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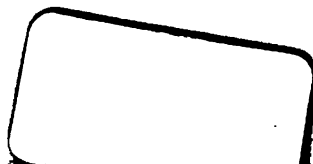
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DEPARTMENT OF MINES

Geological Survey of Queensland.

PUBLICATION NO. 100.

GRAPHITE IN QUEENSLAND

WITH SPECIAL REFERENCE TO THE MOUNT SADDLE GRAPHITE DEPOSIT.

WITH FIVE PLATES

B. DUNSTON, F.G.S.



PRINTED BY THE GOVERNMENT PRINTER, QUEENSLAND.



Queensland.
—
DEPARTMENT OF MINES.

Geological Survey of Queensland.

(B. DUNSTAN, ACTING GOVERNMENT GEOLOGIST.)

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GRAPHITE IN QUEENSLAND

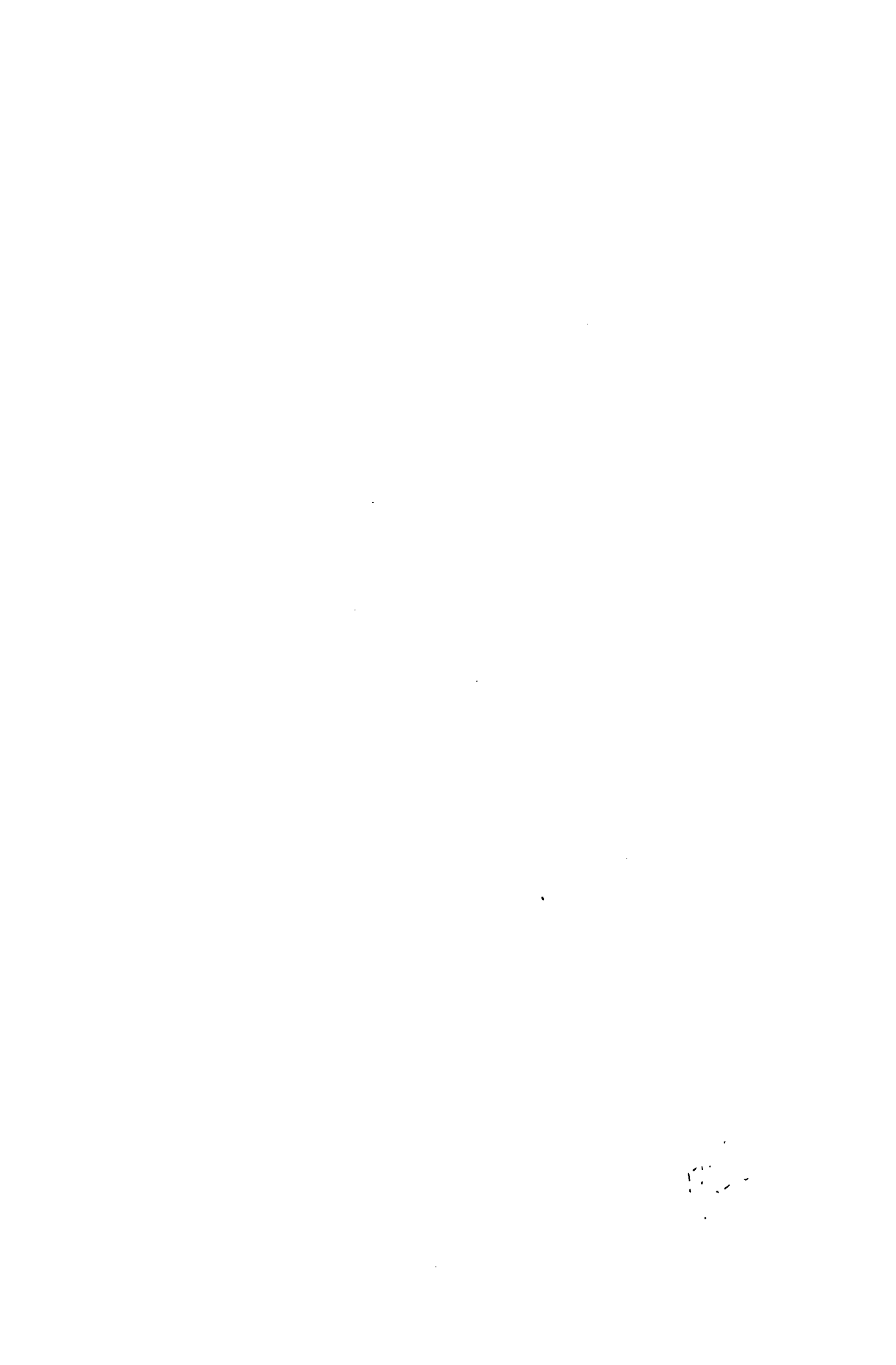
WITH SPECIAL REFERENCE TO THE MOUNT BOPPLE GRAPHITE DEPOSITS.

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BY
B. DUNSTAN, F.G.S.,
ACTING GOVERNMENT GEOLOGIST.



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GRAPHITE IN QUEENSLAND

WITH SPECIAL REFERENCE TO THE MOUNT BOPPLE GRAPHITE DEPOSITS.

INTRODUCTION.

The following notes have been prepared with the object of making available all that is at present known concerning the occurrence of graphite in Queensland. The principal deposits are at Mount Bopple, in the Maryborough district, where the graphite has been found sufficiently pure for commercial purposes, and where mines are now being worked with a view of supplying the demand which has been created for it.

Graphite occurs in other localities in Queensland, and in the following pages reference will be made to these and to the more important foreign sources of supply. Notes will also be given on the dressing, uses, values, and production of the mineral.

THE GRAPHITE DEPOSITS AT MOUNT BOPPLE.

POSITION, ETC.

The Mount Bopple graphite mines are situated on the range close to the North Coast Railway between Gympie and Maryborough, being about three miles south-east of Netherby, and about the same distance north-east of Gundiah. The highest point on the Bopple Range is Beacon Peak, 1,900 feet above sea-level, on which has been erected a trigonometrical staff. The peak, known as Mount Bopple, 1,800 feet high, is the most northerly one on the range, and is about three-quarters of a mile distant from the Beacon Peak.

The two peaks, together with Mount Gundiah, which is about a mile south of Beacon Peak, are connected by a low range having a north and south trend, and on both their eastern and western sides numerous steep and rugged spurs lead down to the flat country at their bases. It is on the spurs leading down from the gap between Mount Bopple and Beacon Peak that the graphite-bearing belt of country is situated. The position of this belt, together with other features, are shown on the accompanying plan. (Plate 1.)

GEOLOGICAL FEATURES.

Burrum coal measures are the prevailing sedimentary rocks around the Bopple Range, and their intrusion by igneous masses has resulted in the strata being much crumpled and faulted.

Mount Bopple, the northern peak, is made up of syenite, syenitic granite, and hornblende andesite, whilst Beacon Peak is composed of andesite and quartz felsite. The syenite is exposed on the western side of the saddle connecting Mount Bopple and Beacon Peak, and it also outcrops on the surface about 60 feet away from a shaft sunk by Mr. Simpson to prospect the graphite deposits on this side of the range. Granite and syenitic granite are exposed lower down the slope, and also further north on some of the spurs leading down from Mount Bopple.

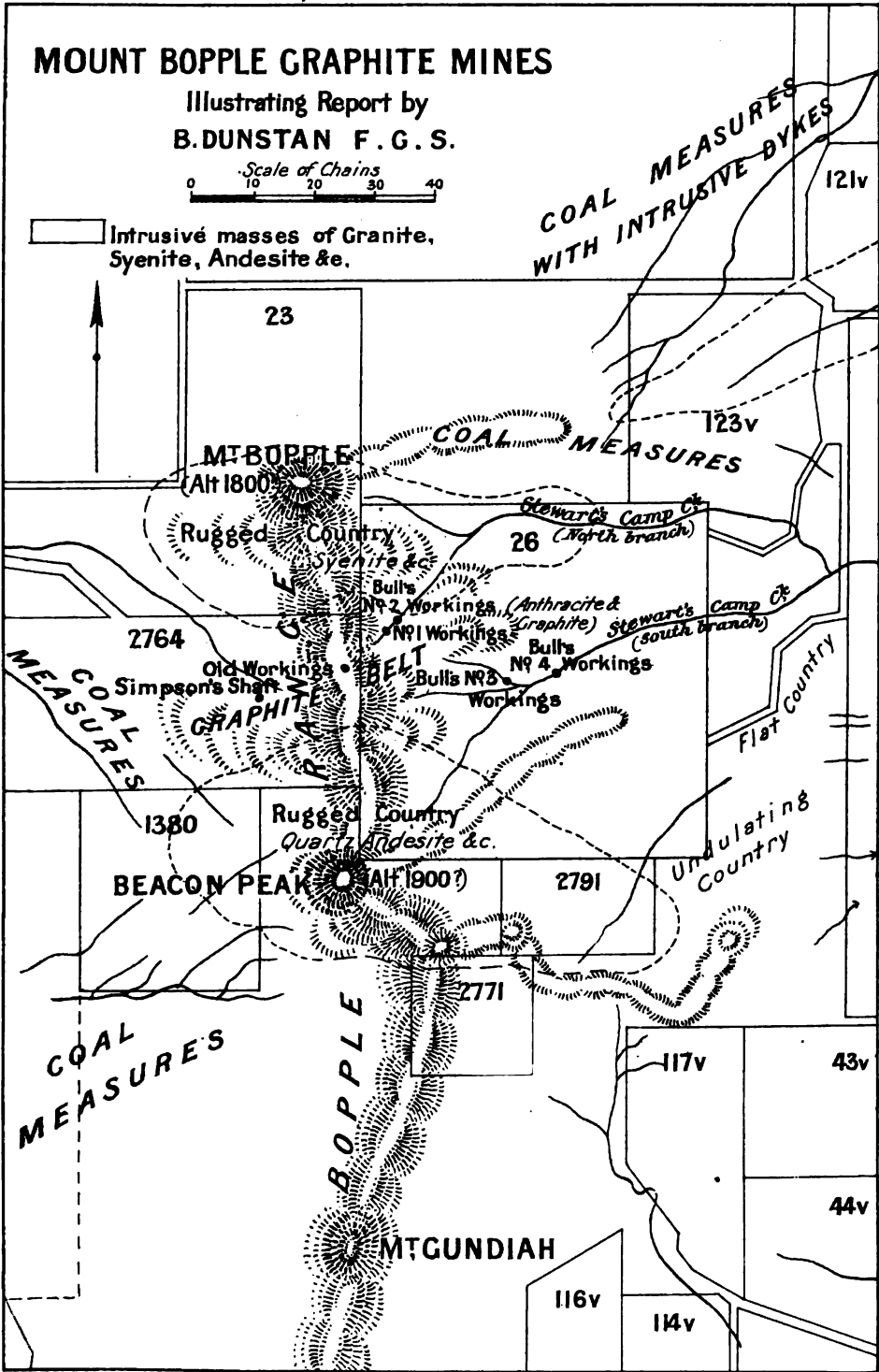
Hornblende andesite is the predominating igneous rock on the eastern side of Mount Bopple, and in several places it is seen in contact with the coal measures. With other varieties of andesite it is also exposed in many localities to the north of the range in the direction of Tiaro, about four miles distant, and about a quarter of a mile west of Tiaro, in the banks of the Mary River, a natural section shows its association with coal measures. The intrusion of these igneous masses appear to have disturbed the sedimentary rocks throughout the district, and to have altered seams of bituminous coal to anthracite or graphite.

The occurrence of aplite was also observed at the graphite mines on the western slope of the range. At Simpson's shaft this rock is found in the graphite in the form of small veins about an inch in thickness, which taper out to leaders, and gradually change to a plumose mica. Occasionally the hornblende of the andesite is found in the form of black cleavable crystals about an inch in diameter, and, no doubt, the rumour that wolfram is found in this locality is due to the presence of this mineral.

The coal measures, containing bituminous coal seams, are exposed in the country all round the mountains, and at Tiaro, Gutchy Creek, Munna Creek, Kannighan Creek, and Redbank Creek outcrops are to be seen which show the strata to be undulating, with occasional areas in which all bedding structure have been destroyed.

Between Mount Bopple and Beacon Peak the coal measures are severely contorted, but an easterly and westerly trend can be distinguished, this direction being the axis of a folding movement which has taken place in the measures lying between the two mountains. This is illustrated on Plate 2, Fig. 2.

On the western slope of the Range the bituminous coal has been altered entirely to graphite, while on the eastern slopes the coal, by almost imperceptible stages, has been changed to semi-bituminous coal, anthracite, and graphite. In one locality the graphite rests on anthracite, with six inches of graphitic clay shale between, the beds of graphite, anthracite, shale, and associated rocks being quite uniform and apparently undisturbed. Sections of this are represented on Plate 3, Fig. 1, and Plate 2, Fig. 1. In the latter section the anthracite is divided into a large number of small bands interbedded with shale.



Illustrating Report on "Graphite in Queensland"

The anthracite is very lustrous and of good quality, but the bands are on an average only about an inch in thickness, whilst the bed of graphite, six inches above, is dull and earthy, and shows no perceptible division into bands of varying quality. The beds above and below are shales and sandstones, and there are no intrusive rocks in direct contact with either the graphite or anthracite. Probably the anthracite has been a coal of good quality, and that the graphite originally has been carbonaceous matter mixed with carbonate of iron. The intrusive masses of hornblende andesite in the vicinity might have induced the change from bituminous coal to anthracite at the same time that the carbon contained in the ironstone was changed into graphite. Subsequent leaching would have removed most of the iron, leaving a residue containing about 50 per cent. of graphitic carbon. Plate 3, Fig. 2, shows a section near Bull's graphite mines illustrating the intrusion of the graphite-bearing strata by dykes of hornblende andesite.

MINING OPERATIONS.

The work of exposing and developing the graphite deposits on the western slope of Mount Bopple are now proceeding at Simpson's mines, and a shaft has been sunk to prove the seams which are exposed on the surface.

The position of the shaft is shown on Plate 2, Fig. 1, the sections of the shaft and the seams being represented on Plate 4. At the first landing in the shaft (marked S. 1 on Plate 4, Fig. 1) a sample was stripped from a seam of graphite four feet thick, and which on analysis yielded 27·10 per cent. of carbon and 69·20 per cent. of ash. At the second landing (marked S. 2) a 3-foot seam of graphite was sampled, and was found to contain 32·28 per cent. of carbon and 62·40 per cent. of ash. Another sample was taken from a 2-foot seam at the third landing (S. 3) which yielded 18·32 per cent. of carbon and 76 per cent. of ash. Other samples were taken from positions lower down in the shaft, and gave results somewhat similar to the above. The whole of the analyses of the samples taken are tabulated on another page.

The seams which were sampled aggregate eleven feet of graphite, having an average composition of 25·59 per cent. of carbon and 69·30 per cent. of ash. Other bands of shale, aggregating 24 feet in thickness, contain a smaller percentage of graphite, while there is about ten feet of shale in which graphite is not present. Sections which have been exposed in the vicinity of the above workings show that other graphite seams are present interbedded with graphitic shales and sandstones, but their quality has not been ascertained.

The inclination of the strata in the upper portion of Simpson's shaft is at an angle of about 45°, but nearer the bottom the angle of dip is much steeper, and in one place is nearly vertical.

Some old workings, opened many years ago by Mr. C. S. A. Drain, are situated close to the gap between Mount Bopple and the Beacon

Peak. They show the graphite to be of the same general character as that exposed in the workings previously referred to, and they have the same alterations of graphite, graphitic shales, and graphitic sandstones. The rocks contain impressions of *Alethopteris australis* and *Phyllothea*, and probably bear a close relation to the Burrum coal measures. Samples from the workings were obtained by Mr. W. H. Rands in 1890, who visited the locality when making a general examination of the geological features of the district.* A picked sample from here gave, on analysis, 6·3 per cent. of moisture and volatile hydrocarbons, 72·7 per cent. of carbon, and 21 per cent. of ash. Another sample taken from a number of bands in a section 36 feet wide yielded 7 per cent. of moisture and volatile hydrocarbons, 44·25 per cent. of carbon, and 48·75 per cent. of ash.

The workings at Bull's mines show that graphite occurs in several localities on the eastern slope of the range, but operations have been principally confined to four places. No. 1 Workings, situated in a ravine on one of the heads of the north branch of Stewart's Camp Creek, are in the vicinity of the line of contact of coal measures and an igneous rock mass. (See Plate 1.) The rocks consist of clay shales, sandy shales, and graphitic shales, and are much inclined. A seam of graphite, four inches thick, has been exposed in a short underlie shaft, and a sample taken from the face of the workings yielded, on analysis, 3·2 per cent. of moisture and volatile hydrocarbons, 16·3 per cent. of fixed carbon, and 78 per cent. of ash.

No. 2 Workings are in an adjoining watercourse, which also falls into the same branch of Stewart's Camp Creek. The sedimentary rocks here are shales, sandy shales, graphitic shales, and sandstones, together with a bed of graphite and a great number of bands of anthracite. Masses of hornblende andesite occur close to the workings, intrusions of which disturb the shales and sandstones and alter their character. The workings consist of a tunnel driven along the inclined seams of anthracite and graphite to a distance of 38 feet. A section of this tunnel is given on Plate 4, Fig. 1. The graphite from this tunnel contains 1·1 per cent. of moisture and volatile hydrocarbons, 74·1 per cent. of fixed carbon, and 24 per cent. of ash. A sample of the anthracite, picked from the bands which, altogether, make up about one-quarter of the whole of the five-foot seam, gave the following result:—

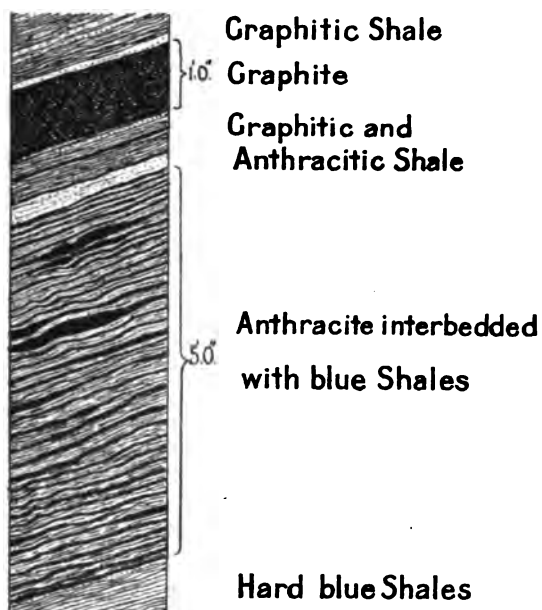
ANALYSIS OF ANTHRACITE BANDS, BULL'S MINE, MOUNT BOPPLE.

Moisture ...	...	...	...	...	...	1·2 per cent.
Vol. Hydrocarbons	...	...	...	...	...	3·3 "
Fixed Carbon	...	...	...	...	...	90·9 "
Ash	...	...	...	...	...	4·6 ,
						100·0 per cent.

* Tiaro District : The Coal Measures, Neardie Antimony Mines, and Teebar and Culgoa Copper Mines, by W. H. Rands. By Auth.: Brisb., 1890, p. 8 G.S.Q.P., No. 59).

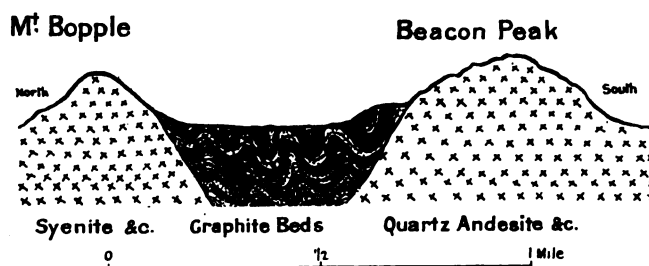
Sections at the Mount Bopple Graphite Mines

Fig. 1



Section at N^o 2 Workings (Tunnel), Bull's Graphite Mine, Mt Bopple
 Illustrating the occurrence of Anthracite with Graphite

Fig. 2



Section along the Bopple Range

Showing the crumpling of the Graphite-bearing Coal Measures
 between Mt Bopple and the Beacon Peak

No. 3 Workings are situated on the south branch of Stewart's Camp Creek, at the position shown on the accompanying plan. (Plate 1.) They consist simply of some excavations in the bed of a water-course in which seams of graphite occur interbedded with the shales. About three feet of the graphite-bearing shales have been exposed, but the surrounding features indicate the probability of other seams of graphite being found if a prospecting shaft were sunk close to the present workings.

At No. 4 Workings, which are lower down on the same water-course, a four-foot seam of graphite has been exposed, and proves to be the largest of those discovered on the eastern side of the range. The cliffs in the vicinity show several small graphite seams interbedded with shales, and possibly others exist whose outcrops are covered by *débris*. A short tunnel has been driven into the four-foot graphite seam, a sample from which yielded, on analysis, 3·2 per cent. of moisture and volatile hydro-carbons, 16·3 per cent. of fixed carbon, and 78 per cent. of ash. A sketch section of No. 4 Workings is given on Plate 4, Fig. 2.

Other places in the vicinity of Bull's workings indicate the presence of several graphite deposits, and as there are here large areas known to be graphite-bearing, and many natural sections of rock exposed which have not been carefully examined, seams of better quality will probably be found as prospecting operations are advanced.

TABLE OF ANALYSES OF MOUNT BOPPLE GRAPHITE.

No.	Moisture and V. H. C.	Mixed Carbon.	Ash.	COMPOSITION OF ASH.			
				Silica.	Alumina.	Lime.	Alkalies, &c. (by difference).
1	5·70	27·10	69·20	61·80	30·20	1·90	6·10
2	5·32	32·28	62·40	58·30	35·80	1·70	4·20
3	5·68	18·32	76·00	58·10	35·60	1·30	5·00
4	4·46	22·14	73·40	55·60	37·20	2·70	4·50
5	5·26	25·74	69·00	59·00	25·00	2·00	1·00
6	5·22	27·98	66·80	59·80	35·10	1·40	3·70
7	2·50	16·10	80·10	Ash is mainly Silicate of Alumina.			
8	3·20	16·30	78·00				
9	3·50	15·60	79·50				
10	2·80	46·30	51·10				
11	1·10	74·10	24·00				
12	2·40	10·80	82·80				
13	6·20	72·70	21·00				
14	7·00	44·25	48·75				
15	4·40	90·90	4·60				

NOTE.—A little iron and magnesia is present in all samples, but sulphur is absent

LOCALITIES FROM WHICH THE ABOVE SAMPLES WERE TAKEN.

- No. 1. Simpson's shaft, No. 1 landing, 4-foot seam.
- No. 2. Simpson's shaft, No. 2 landing, 3-foot seam.
- No. 3. Simpson's shaft, No. 3 landing, 2-foot seam.
- No. 4. Simpson's shaft, No. 4 landing, 1 foot 6 inch seam.
- No. 5. Simpson's shaft, No. 5 landing, 6-inch seam.
- No. 6. Simpson's shaft, sample from 6-ton parcel prepared for market.

No. 7. Bull's No. 4 Workings, sample from 6-ton parcel bagged for market.

No. 8. Bull's No. 4 Workings, from working face in short tunnel at No. 4 Workings.

No. 9. Bull's No. 3 Workings, from outcrop in watercourse (above No. 4 Workings).

No. 10. Bull's No. 1 Workings, from 4-inch seam in inclined tunnel.

No. 11. Bull's No. 2 Workings, from 1-foot seam in 38-foot tunnel.

No. 12. Bull's No. 2 Workings, from excavation in bed of watercourse.

No. 13. Drain's old workings, picked sample by Mr. Rands.*

No. 14. Drain's old workings, average sample from bands interbedded with shales, in a 36-foot section (by Mr. Rands).*

No. 15. Bull's No. 2 Workings, bands of anthracite below bed of graphite.

OTHER QUEENSLAND GRAPHITE DEPOSITS.

MACKAY DISTRICT.—The deposits of graphite in Selections 776 and 777, parish of Eton, was inspected in 1896 by Mr. A. Gibb Maitland, who furnished a report (unpublished) concerning their occurrence. He states that the graphite is associated with beds of shales and quartzites, traversed by what appears to be both interbedded and intrusive masses of igneous rocks.

In one locality on Scrubby Creek, the graphite has been exposed just above the level of the watercourse, and a prospecting tunnel has been driven into it for a distance of 80 feet. In thickness the "vein" averages about 18 inches, and has a perceptible dip to the north-east, while further along the bed of the gully the vein has a thickness of over four feet. About 20 tons of this graphite was bagged for experimental purposes, but the results of the trial have not been ascertained.

Another thin vein of graphite is exposed about eight feet above the one just referred to, but nothing has been done to determine its thickness or quality. Further up the course of the gully another mass of graphite associated with black shale is exposed, and is almost in contact with an intrusive rock. Nearer the head of the gully there are beds of shale exposed, which have been disturbed by these intrusions, whilst indications of the presence of graphite are to be noticed in several places near the same watercourse. In Palm-tree Gully, to the north of Scrubby Creek, graphite is to be found under similar conditions, and in several other localities outcrops of graphite and graphitic shales are also known.

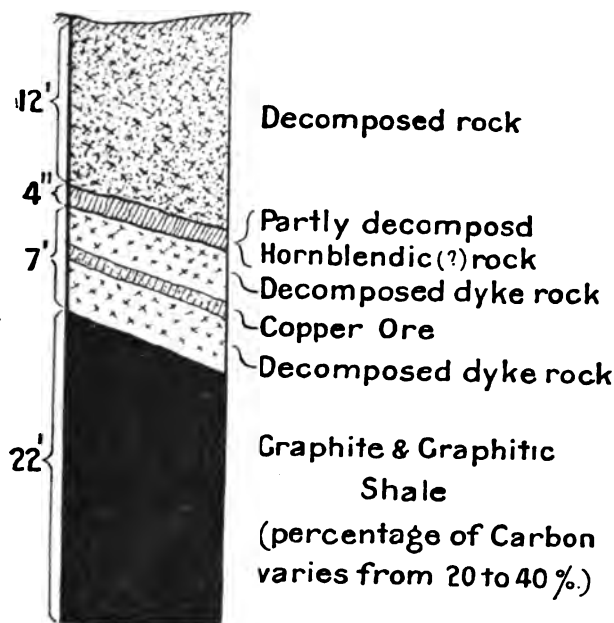
The western side of Selection 777 consists of basalt with underlying shales, and the flanks of Homebush Hill, in Selection 776, are made up of horizontally-bedded shales with interbedded deposits of graphite, none of which, however, have been examined.

* *Loc. cit.* (G.S.Q.P. No. 59), p. 4.

The graphite from the localities in this district, according to Mr. Maitland, contains from 15 to 70 per cent. of graphitic carbon, and at the time he made the examination considered the deposits to be worth further attention.

CLONCURRY.—Graphite was discovered near Cloncurry in 1880,* but for many years no further exploration has been made of it. Quite recently, however, samples of graphite have been received from Hampden, near Cloncurry, where a large deposit exists. Most of the material is of an inferior quality, but some portions contain 40 per cent. of carbon. A shaft sunk to prospect for copper penetrated a large mass of graphite of unknown dimensions, of which Mr. Jas. Long furnishes the following section:—

Section of Graphite Deposit, Hampden.



STANTHORPE DISTRICT.—Graphitic slate is present in the Silver Spur Mine at Texas,† but its quality does not warrant any consideration being given to it as a commercial product. At Wilson's Downfall, on the New South Wales border, graphite occurs in abundance; but up to the present the deposits which have been found have proved to be inferior in quality. Much requires to be done, however, before any definite conclusion can be arrived at as to their value.

* Annual Report of the Department of Mines for 1880, p. 31.

† Notes on Tin, Copper, and Silver, in the Stanthorpe District, by L.C.B. By Auth.: Brisb., 1904, p. 31 (G.S.Q.P., No. 191).

CAPE UPSTART.*—Deposits of graphite are known at Cape Upstart, on the coast between Townsville and Bowen, but they have not been developed to any extent. Prospecting operations which are now in progress show that the seam of graphite varies from four to eight feet thick, and is in coal measures close to a mass of igneous rock. The quality appears to be similar to that of the graphite at Mount Bopple.

GYMPIE.—Graphite is intimately associated with the reefs which traverse the slates of this goldfield. The quality is very poor, and of no commercial value.

CROYDON.—The granitic and felsitic rocks prevailing on this goldfield contain small quantities of graphite.† In the granite it is found as irregular inclusions, and is much contaminated with clay. In the felsites it is in the form of flakes, very pure in quality, but finely disseminated.

HAMILTON GOLDFIELD.—The quartzites associated with the reefs on this goldfield contain a quantity of graphite in the form of flakes.‡

NORMANBY GOLDFIELD (Reid's Creek).—A large deposit of graphite has been found on Rosslyn Run, near Greenbank, but no authentic information has been obtained concerning its quality.§

YORKEY'S GOLDFIELD.—In Campbell's reef on this field graphite is associated with pyrites and quartz.

NEW GUINEA.—"The presence of graphite or plumbago has been demonstrated over nearly the whole of the known portion of the Possession, but always as an accessory constituent of the schists; in some cases it occurs in such a quantity as to give a distinctive character to the rocks. In the most graphitic of the schists, although the quantity is proportionally large, to remove the impurities (chiefly quartz) by washing or other means would be too costly to be remunerative."||

NOTES ON GRAPHITE IN NEW SOUTH WALES.

A deposit of graphite-bearing shale is exposed near Underwood Station, about twelve miles from Wilson's Downfall, near the Queensland border. It is interbedded with sedimentary rocks which have been altered by an intrusive mass of granite. A trial has been made of the graphite by the Springfield Facing Company, Massa-

* Mineral Wealth of Queensland, by R.L.J. *Brisb.*: By Auth. 1888, p. 67 (G.S.Q.P., No. 48).

† Some Croydon Gold Mines, by B.D. *Brisb.*: By Auth., 1905, pp. 9-10 (G.S.Q.P., No. 202).

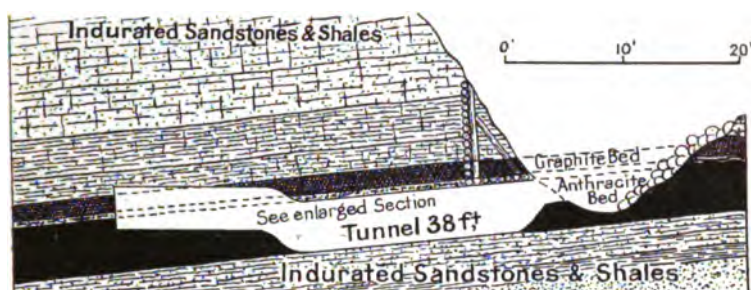
‡ The Hamilton and Coen Goldfield, by L. C. Ball. *Brisb.*: By Auth., 1901, p. 4 (G.S.Q.P., No. 163).

§ Annual Report of the Department of Mines, 1887. *Brisb.*: By Auth., 1888, p. 54.

|| Geological Observations in British New Guinea, by A. Gibb Maitland. *Brisb.*: By Auth., 1892, p. 32 (G.S.Q.P., No. 85).

Sections at the Mt Bopple Graphite Mines

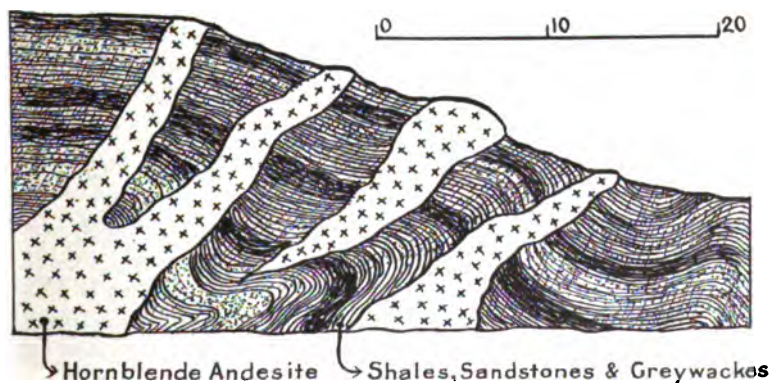
Fig. 1



Section of N^o 2 Workings Bull's Mine

Showing the position of the beds of Sandstones,
Shales, Graphite and Anthracite

Fig. 2



Section near Bull's Graphite Mines

Showing the intrusion of the Graphite-bearing beds
with Hornblende Andesite

chusetts, and the following report was furnished:—"We are positive that it would make a very good facing, and could be used to advantage wherever German "lead" (plumbago) is used in the manufacture of foundry facings. It is true that it would probably be impossible to ship it to this country at the price we pay you, as we can buy a powdered German lead at $1\frac{1}{4}$ cents in New York, or an Italian lead, which closely resembles it, at about 16 dollars per ton. On any work in the foundry where the facing is used wet—such as dry sand or cores—it would be a very good article indeed, and in any market you could reach we think it would pay to have same used."—(Min. Resources of N.S.W., by E. F. Pittman.)

In New South Wales deposits of graphite are also known to occur at Grafton, Mudgee, Fairfield, Hillgrove, Tobin's Creek, Cowell Creek, near Port Macquarie, Dundee, Tenterfield, Pambula, Cordeaux River, Plumbago Creek in the county of Drake, and at the head of the Abercrombie River.

NOTES ON SOME BRITISH AND FOREIGN GRAPHITES.

With the occurrence of so many deposits in Queensland, and so many possibilities of finding a higher grade graphite than that already known, some information concerning foreign deposits might prove useful. There are some discrepancies and apparent inconsistencies in the data given below, but no means are available for checking the accuracy of the varying statements made in the works consulted, so the information can be taken for what it is worth.

CEYLON.—The mines of Ceylon are the largest in the world, and the graphite produced is of such high quality that it may be taken as the market standard. An average analysis of high-grade Ceylon graphite is as follows:—

CEYLON HIGH-GRADE GRAPHITE.

Volatile matter	...	...	...	...	0.310 per cent.
Carbon	...	...	...	...	98.284 „
Ash	...	...	...	...	0.415 „

The country rock is granite, gneiss, &c., partly decomposed, in which the graphite, in the form of coarsely foliated masses, occurs in true fissure veins.

ITALY.—The mines at Pinerolo district of Piedmont produces a graphite containing from 10 to 80 per cent. of carbon. The raw material, after grinding, contains, on an average, about 61 per cent. of pure graphite.

BAVARIA.—At the Passau mines the graphite occurs as an impregnation of gneissic rocks, and is closely associated with beds of limestone. The graphite is of poor quality, the best undressed material

containing 53·8 per cent. of carbon, the inferior 31·72 per cent. The dressed article contains 89·2 per cent. of carbon, and the waste material from 22·3 to 36·8 per cent.

CUMBERLAND, ENGLAND.—The old Borrowdale graphite mines have been practically idle for the last forty years, and are exhausted. The graphite is in the form of nests and lumps, and occurs in veins of quartz and calcite which traverse greenstone porphyry. The graphite produced from these mines was a fine flake variety, used principally in the manufacture of lead pencils.

BUCKINGHAM, QUEBEC.—In these Canadian mines the graphite is disseminated in gneiss, &c., the deposits varying in thickness from a few feet to 25 feet. The proportion of graphite to rock is from 10 to 50 per cent., but in one particular bed, 20 feet in thickness, the average yield is 20 per cent. of graphite. The raw graphite has the following average composition, and considerable quantities of this rock has been mined:—

ANALYSES OF BUCKINGHAM GRAPHITE.

Hygroscopic moisture	...	...	...	...	1·740 per cent.
Soluble in HCl	...	...	...	...	19·467 „
Insoluble	...	...	...	...	56·408 „
Carbon	...	...	...	...	22·386 „

ONTARIO.—Considerable quantities of graphite are obtained at the mines at Renfrew, but it is stated that the industry is only carried on profitably when the percentage of graphite in the gangue is more than 15 per cent. At the Black Donald Mine the total amount of graphite in the product is about 65 per cent., of which about 45 per cent. is amorphous, the remainder being the flake variety. Some portions of the deposit yield a graphite containing as much as 80 per cent. of carbon, whilst low-grade portions contain about 25 per cent. of carbon. The graphite occurs as a vein in crystalline limestone, and is associated with seams and pockets of chlorite, and is close to schistose rocks.

At the McConnell Mine, near Perth, Lanark County, the product, which is in a flake form, contains much less carbon than that at the Black Donald Mine. The country rock is limestone, and the graphite occurs in zones or veins several hundred feet long.

BOHEMIA.—The Schwarzbach-Kruman deposits are lenticular in shape, and are associated with limestones. The graphite is much desired for pencils, and in being compact and without foliation is admirably suited for this purpose. The refined graphite contains from 50 to 60 per cent. of carbon.

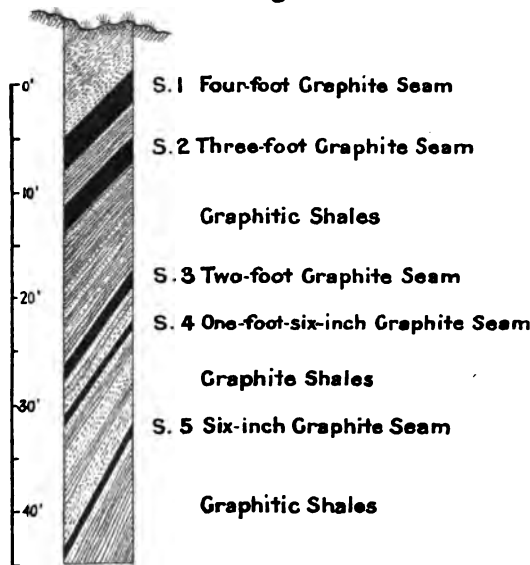
STYRIA.—The deposits in this locality are associated with strata belonging to coal measures. The graphite produced contains from 73·8 to 88·5 per cent. of carbon, and analyses show it to have the following average composition:—

ANALYSES OF STYRIAN GRAPHITE.

Alumina	...	...	...	...	...	6·12 per cent.
Silica	...	...	...	...	...	13·04 „
Carbon	...	...	...	...	...	77·95 „

Sections at the Mount Bopple Graphite Mines

Fig. 1



Section of Shaft at Simpson's Mine
Showing the position of the Graphite Seams
(See accompanying table for analysis)

Fig. 2



Section across the South Branch of Stewarts Camp Creek
Showing Nº4 Graphite Workings at Bull's Mine

As the silica is the principal impurity, the graphite is very refractory, and in consequence is in great demand for the manufacture of crucibles.

IRKUTSK, SIBERIA.—At the Batugol mines the graphite is of very fine quality, and much used in pencil-making. It occurs as fibrous lumps in veins traversing granite and diorite, and is closely associated with an altered limestone.

TICONDEROGA, NEW YORK.—The mines at this locality are worked by Dixon, and are the principal source of supply in the United States. The rock as mined averages ten per cent. of graphite, but deposits are said to be worked which yield not more than six per cent. These deposits are stated to be "elliptical chimneys in gneiss, which have been filled with calcite and graphite."

AUSTRIA.—The Northern Moravian mines produce a graphite containing 53 per cent. of carbon, and 44 per cent. of ash.

SOUTH DAKOTA.—The graphite found at Rockford, in this State, contains from 26 to 41 per cent. of carbon, which, without being accompanied by other higher grades, is considered too low in quality to profitably mine.

MEXICO.—Mexican graphite varies from 40 to 50 per cent. in carbon contents.

CORONA, U.S.A.—"Corona" graphite contains 57 per cent. of carbon and about 40 per cent. of ash. It is the material now being used by the Southern Pacific Railway Company for paint, fine lubrication, foundry facings, and hot-box grease.

INDIA.—Samples have been submitted to the Imperial Institute from the Chatisgarh district, and were found to contain respectively 40·95, 37, 79·91, 69·67, 63·70, and 54·73 per cent. of fixed carbon. The sample containing 79·91 per cent. of carbon was not considered sufficiently pure to be used in the making of crucibles, and could only be utilised for stove-polishing and similar purposes, and would be worth about £10 per ton. The remaining samples, except that containing 69·67 per cent. of carbon, were said to be of very little value. It is further stated that the supply of graphite having less than 85 per cent. of carbon was very much in excess of the demand, and that in consequence such quality could only command a low price.

ARTIFICIAL GRAPHITE.

Artificial graphite is manufactured by the International Acheson Graphitic Company, Niagara Falls, New York, U.S.A. The method of its manufacture was discovered by Mr. Acheson while developing some experiments in the making of carborundum, a substance having a hardness greater than emery, and now used extensively as an abrasive.

The silicon which is combined with the carbon in carborundum is vaporised at a very high temperature, and the carbon, in the form of graphite, remains as an infusible residue. Additional experiments showed that anthracite coal can be converted into graphite.

In conducting the operations of converting anthracite into graphite, the anthracite is heated for a number of hours in an electric furnace with an expenditure of energy equivalent to 1,000-h.p. "The furnace consists of a long narrow trough made of fire brick, and lined with some suitable refractory material. At each end of the trough there is a terminal, built of large carbon rods to which are connected the cables conveying the current. The trough is filled with anthracite coal in which is bedded carbon rods to make electrical connection between the terminals. The temperature is raised to a point where the carbon is first converted into carbides of the various constituents of the ash, which in anthracite coal is very evenly distributed throughout the mass, and is then carried still higher to a point at which the carbides are decomposed, the principal constituents of the original ash, silicon, iron, and aluminium being driven off as vapours."

"The residue removed from the furnace is carbon in the form of graphite, perfectly free from any trace of amorphous carbon. The purity of the graphite depends on the temperature to which it has been raised, and for commercial purposes it is found sufficient to keep the ash contents below ten per cent. When reduced to this percentage the ash still remaining in the graphite is practically as inert as the graphite itself. When removed from the furnace the graphite is ground up and the grades suitable for various purposes separated."—(Pamp.—Acheson Co.)

CONCENTRATING AND DRESSING GRAPHITE.

The means employed in dressing the graphite for market comprise operations in crushing, screening, air jigging, and sizing, and the operations at the Black Donald and McConnell mines, previously referred to, may be taken as examples.

At the McConnell Mine the operation is as follows:—"After coarse crushing and drying, the ore is reduced to a fine size and screened several times to remove a considerable proportion of the limestone gangue as dust. A cleaner separation of the intermixed rock is effected by concentrating in pneumatic jigs, and the concentrates are then ground in a series of millstones. The polished and enriched flake discharged from the last stone undergoes wet buddling in small vats, which finish the work of concentration, after which the graphite is again dried, preparatory to the final grading in revolving screens into two or, when desired, more sizes, the coarsest being from fifteen to twenty mesh size. On account of the low content of carbon in the crude ore, this elaborate scheme of concentration has been adopted in order that the saving should be as high as possible. The flake product

is of high grade suitable for crucible stock. The capacity of the McConnell refinery is from 15 to 20 tons of ore per day."—"Min. Industry," 1902.)

The Black Donald refinery has a capacity of 15 tons per day, and uses a wet process of concentration with large buddles. "All of the material but the tails is dried either in an electric-heated or ordinary fire-heated revolving cylinder, sized, and then ground between mill-stones, which pulverise the gangue and amorphous graphite and merely polish the flake. After grinding, the product is passed through a series of revolving screens of gradually decreasing mesh, by which four sizes of flake are separated out, then a mixed flake and amorphous grade, and finally four or more sizes of amorphous graphite. The first flake is the coarsest and cleanest product, running about ten-mesh size and 96 per cent. C.; the remaining grades of flake decrease in size, but all are over 90 per cent. pure. The amorphous grades are in powder form and carry from 54 to 62 per cent. C. The limestone remaining with the graphite after buddling pulverises more readily than the graphite, and in the screening separates out from the graphite as dust."

"This mine is exceptional, both as regards uniformity and quality of the graphite, and size of the deposit. Since the erection of the refinery practically all the ore may be converted into valuable products, chief of which are the grades of flake for use in the manufacture of crucibles."—(Mineral Products, 1902.)

In the "Mineral Resources" for 1902, p. 976, it is stated that "there are two methods of concentrating graphite from its ore, the wet and the dry. No mill has adopted the dry or air method in its entirety, on account of the gravities of the component parts of the ore being so close to one another. Several pneumatic processes have lately proved a partial success, but they have been of limited application on account of the inability to remove the small scales of mica which occur in some of the deposits. The wet or water method of concentration has been developed to a marked degree of efficiency, and is the one now used by the operative companies (*sic*). The general method of procedure is to crush the ore, stamp it wet, separate coarsely by stationary buddles, the concentrates being dried and further treated with buhrstones and screens."

At the Buckingham mines the mill has a capacity of 20 tons per day, treats 25 per cent. ore, and gives daily about three tons of a finished product, which contain 60 per cent. of graphite. The ore, after crushing and drying, is treated on a Brunell separator, a machine designed to clean the graphite by floating it on the surface of water.

A process of treating the graphite consists in grinding the ore, and then passing it through sieves having from 120 to 150 meshes to the inch, afterwards adding steatite and alum. The average composition of this mixture would be eighty parts of graphite, fourteen parts of steatite, and six parts of alum, but this is subject to variation

according to requirements. It is said that a graphite thus treated will bind together, which, before treatment, will not do so, and that a graphite which will only bind to a limited degree is much improved by the treatment.

Finely-powdered graphite, after washing, is sometimes purified by mixing fourteen parts of it with one part of potassium chlorate and two parts of 66° sulphuric acid, heating on a water bath for some hours, and then washing again and roasting to a red heat. This removes most of the substances which cannot be removed in the ordinary washing processes. Silica, if present, and if desirable to remove, necessitates supplementary treatment with hydrofluoric acid.

In the Mount Bopple graphites, the amorphous condition of the carbon, and the presence of the silica and clay in a fine state of division, suggests that a difficulty would be experienced in treating it by any method of mechanical concentration, and that in consequence hand-picking would have to be relied on to grade it up to a marketable quality.

USES OF GRAPHITE.

Graphite is used in the manufacture of crucibles, stove polish, foundry facings, paints, pencils, steam-packing, dry batteries, and in electrotyping and chemical operations.

Lubricants require a high-grade flake graphite, none but the very best material being used for this purpose. Many processes have been devised for utilising the graphite in this way, but the most recent method, which gives promise of being successful, consists in saturating the powdered graphite with oil, and then suspending it in another oil which will not mix with that used in the saturation of the graphite. Mixed with grease, the graphite forms, ordinarily, a lubricant for journals, but the new method of preparation with oil will enable it to be used extensively in the lubrication of cylinders. Mixed with an equal proportion of grease, the graphite is used as a hot-box "cooler."

In the manufacture of crucibles, the flake form is required, and usually a very high-grade quality is indispensable. The flake variety has a tendency to bind together when worked up into articles, whilst the amorphous kind has not this property. Intermediate qualities, in having some of the properties of flake graphite, may be used in the manufacture of crucibles, but they will not stand more than one heating, and have to be crushed and moulded again. When the material of which the pots are made is too coarse, the pots are found to be porous, and if too fine, they are very liable to crack. Graphite which has only a slight binding property may be improved by treating with alum, &c., in the manner mentioned above.

Crucibles of good quality (as manufactured by Dixon) contain 50 per cent. of carbon, 33 per cent. of clay, and 14 per cent. of sand, but it is necessary to first obtain the graphite very pure and mix the



SIMPSON'S GRAPHITE MINE, MOUNT BOPPLE
(NEAR THE NETHERBY RAILWAY STATION).

substances with it afterwards. Raw graphite cannot, as a rule, be used for this purpose on account of the impurities it contains, although in the case of the Styria graphite referred to, the composition of the raw article shows that none of the silica and alumina would require to be removed as impurities, and that it would only be necessary to add sufficient clay and silica to make up the proportion required of those ingredients in the manufacture of crucibles.

"The material for making crucibles is sieved through screens containing from 40 to 100 meshes to the inch. The clay should be refractory, and the sand is passed through a forty-mesh screen. The clay is made into a thin paste with water, and sand and graphite are mixed in, and the dough is then passed several times through a pug-mill, after which it is tempered for several weeks in a damp place. Weighed lumps of the tempered dough are then kneaded and moulded on a wheel, which is considered to be better than simple pressing, as the graphite flakes are arranged tangentially and bind the mass better. The crucibles are placed in plaster moulds and left for three hours, during which time the plaster absorbs part of the moisture; they are then dried for a week at a temperature of 70° to 80° Fahr., and burned in a common pottery kiln, which is first fired with anthracite coal and afterwards with long-flaming wood. The burning takes a week, the temperature reaching about 1,350° C."—"Min. Industry," Vol. 2 (1893), p. 341.)

Stove polish, foundry facings, and electrotyping requires a low-grade graphite, and the amorphous variety is principally used for such purposes. In Canada the graphite used for foundry facings is only considered good when it contains 50 per cent. of carbon.

Pencils are made from "flakeless" graphite, but for this purpose the material must be very fine in grain and of the purest quality. The Batugol mines at Irkutsk, in Siberia, are said to produce a very fine quality of graphite for lead pencils.

Its use as moulds in metal-casting is also recommended as a substitute for iron, and is supposed to have some property which makes it specially suitable for this work. As a substitute for white and red lead it is stated to give great satisfaction, and in using it as a cement for pipe joints the iron is said to remain clean, even though the faces are exposed for a considerable time to the action of steam.

Graphite is very extensively employed in the composition of paints, some manufacturers using a low-grade article, while others consider that a high-grade graphite is more suitable. The paints on the market made from various natural graphites contain 50 per cent. or less of graphite, the other portion being made up of silica, oil, &c. It seems, however, that the manufacturer requires a graphite of good quality to operate upon, and would not think of using a natural graphite unless it contained considerably more than 50 per cent. of carbon.

The consumption of graphite for the various uses to which it is applied is tabulated below, from which it is seen that crucibles absorb more than half the whole of the production:—

Crucibles ...	...	...	...	...	...	55 per cent.
Stove polish ...	...	...	...	...	...	15 "
Foundry facings ...	...	...	...	...	...	10 "
Paints ...	...	...	...	...	...	5 "
Other uses ...	...	...	...	...	...	15 "
						100 per cent

GRAPHITE PRODUCTION AND VALUES.

In Australia the imports and production of graphite (which is also classed under plumbago and black lead) are not definitely known, but the following returns are furnished from all the statistical references available:—

VICTORIA.—Imported 555 tons during the four years, 1899 to 1902 (value £5,543, or about £10 per ton).

NEW SOUTH WALES.—Imports (no returns). Produced in 1894 16 tons, valued at £68; and in 1896, 80 tons, valued at £160.

QUEENSLAND.—Imported 113 tons during the six years, 1899 to 1904, value £3,154 (or about £26 10s. per ton).

SOUTH AUSTRALIA.—Imported 19 tons during the year 1903, value £294 (or about £15 9s. per ton).

TASMANIA.—Imported 8 tons* during the two years, 1901 and 1903, value £212 (or about £26 10s. per ton).

WESTERN AUSTRALIA.—The value of the imports during 1901 was £46.

The United States consumes almost all the natural graphite produced in that country, and with England absorbs about 80 per cent. of the whole of the higher grades produced in all parts of the world.

The production of graphite in the United States, during the year 1902, amounted to (a) 2,000 tons of refined graphite, valued at £20 per ton; (b) nearly 4,700 tons of amorphous graphite, valued at £2 15s. per ton; and (c) over 1,000 tons of artificial graphite, valued at £22 10s. per ton.

From this an opinion may be formed of the value of Queensland graphite as an article of export. At all the localities in Queensland where graphite exists in quantity, only the amorphous variety has been found, and this could not be expected to realise more than the prices quoted for the same variety in the United States. In England the same prices prevail.

As an article of trade within the Commonwealth however, it has decidedly an advantage over the imported graphite of the same class, and the demand for it in connection with foundry work will certainly increase when once those who are using the imported article can be persuaded to give the Queensland product a trial.

* Estimated.

21579
DEPARTMENT OF MINES

Queensland Geological Survey

G. DUNN, ASSISTANT GOVERNMENT GEOLOGIST

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THE WEST MORETON (IPSWICH) COALFIELD
SECOND REPORT ON

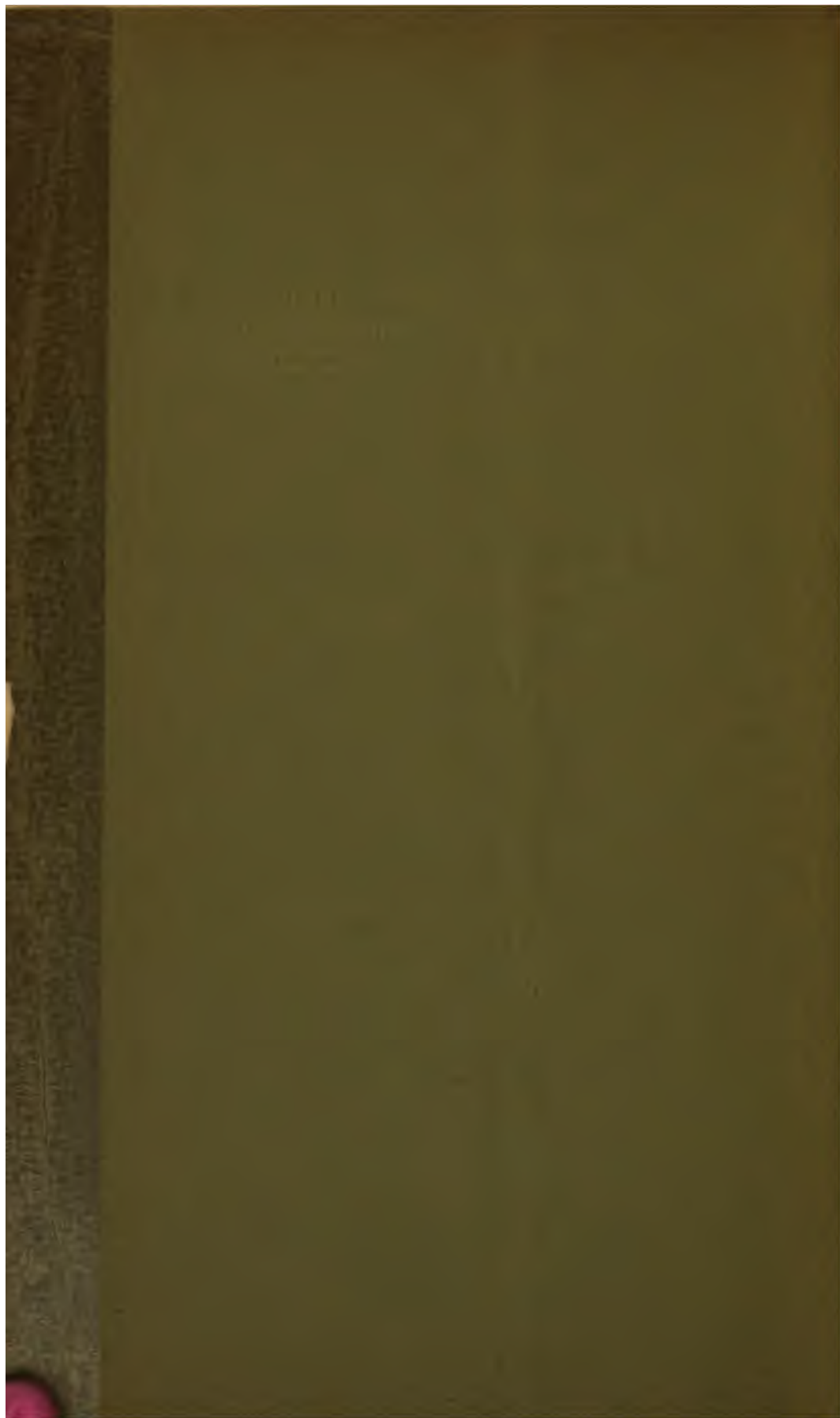
THE LOCAL REFERENCE TO THE SUDAN (THE DISTRICT)

WITH 2 MAPS, 1 PLATE AND 6 FIGURES

WALTER E. CAMERON, B.A. (HONORS)
ASSISTANT GOVERNMENT GEOLOGIST



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PUBLICATION No. 204.

THE WEST MORETON (IPSWICH) COALFIELD
SECOND REPORT ON.

(With Special Reference to the Bundamba District.)

WITH 2 MAPS, 1 PLATE, AND 8 FIGURES.

BY

WALTER E. CAMERON, B.A. (Cantab.),
ASSISTANT GOVERNMENT GEOLOGIST.



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THE WEST MORETON (IPSWICH) COALFIELD

WITH SPECIAL REFERENCE TO THE MUNDAMBA DISTRICT.

SECOND REPORT.

Chapter I.—General.

I.—INTRODUCTION: PRODUCTION AND PROSPECTS.

The West Moreton Coalfield is at present the chief producing coalfield of the State, its importance being due, in the first place, to the generally useful character of its coal for ordinary commercial purposes, such as marine and land steaming, coke-making, blacksmithing, and gas-making; and, in the second place, to the proximity of the field to the chief industrial centre and most important shipping port of the State. This latter circumstance will always be an important and favourable factor in the future prosperity of the field, as it will command an easily accessible and constantly growing market, where less favourably situated fields can only compete under the disadvantages of higher freight charges for transport from the mine.

During the last five years the Ipswich Field has turned out more than 75 per cent. of the total coal production of Queensland; its average annual output for that period having been a little under 400,000 tons. This represents a value to the Ipswich district annually of about £120,000.

The diagram shown in Fig. 1 gives a graphic representation of the important part played by the Ipswich and Darling Downs fields combined in the total output of the State during the last twenty years. As the returns from these two districts have not been kept separate, it is not possible to show those from the Ipswich Field alone; but, as

the figures for the former district constitute only about 5 per cent. of the total of the two combined, the diagram would not be materially altered by their exclusion.

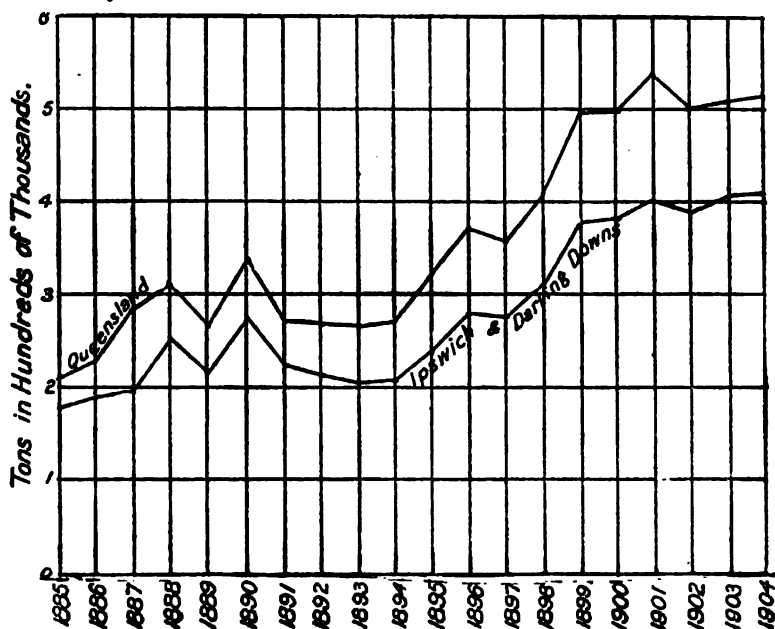


FIG. 1.—PRODUCTION OF QUEENSLAND COAL DURING TWENTY YEARS ENDED 1904.

As shown by the diagram and Table I., the annual output of coal from Queensland mines increased during the years 1894 to 1899 from 270,705 tons to 494,000 tons, or by over 80 per cent.; while for the succeeding five years the increase of output did not amount to 4 per cent. This sudden check to expansion was no doubt primarily due to the disastrous drought, the effects of which have paralysed Queensland trade generally during the last five years; and, as a natural consequence, greatly curtailed the coal consumption of the State. The rapid increase of demand shown by the former five-year period led to the opening up of a number of new collieries, especially along the southern extension of the outcrop of the Aberdare seam, during the latter five-year period; while the increase of competition thus brought about was not met by any corresponding increase in the demand for coal. The consequence has been a glut of the market, so that at the present time the output necessary to keep the mines now opened up in full work is in excess of the demand. As a consequence, nearly all the pits are periodically idle.

Efforts have been made to meet this expanding production by working up an export trade to foreign countries; but, so far, without much success. The coal is of a brittle character, and, with the

exposure to weather and rough treatment inseparable from such a trade, becomes quickly converted into slack. It consequently cannot be expected to compete with the durable coals of the Newcastle district, which are even more favourably situated as regards shipping facilities for such a trade.

TABLE I.—SHOWING PRODUCTION OF QUEENSLAND COAL FOR 20 YEARS ENDING 31st DECEMBER, 1904.

Year.	Queensland.	Value.	West Moreton and Darling Downs Coalfields.	Value.
	Tons.	£	Tons.	£
1885	209,698	87,228	180,744	71,258
1886	228,656	95,243	189,608	72,054
1887	283,813	97,460	193,286	71,851
1888	311,412	127,947	254,778	98,851
1889	265,507	121,118	217,240	195,202
1890	338,344	157,077	276,063	120,476
1891	271,603	128,198	222,766	97,757
1892	265,086	123,308	215,535	91,798
1893	264,403	125,340	204,429	86,582
1894	270,705	114,593	207,672	81,201
1895	323,068	132,530	339,712	89,150
1896	371,390	154,987	280,094	106,740
1897	358,407	139,889	277,172	97,411
1898	407,934	150,493	310,444	103,927
1899	494,009	175,715	373,655	127,305
1900	497,132	173,705	379,504	126,425
1901	539,472	189,877	420,500	139,860
1902	501,531	172,286	390,603	127,851
1903	507,801	164,798	403,462	124,479
1904	512,015	166,536	408,186	124,339

Table II., the figures for which were kindly supplied to me by the Commissioner for Railways, shows the amount of coal railed from the Ipswich district for consumption in various industries in Brisbane. It shows that the Ipswich district depends most of all for its market on the employment of the coal for marine steaming purposes by steamers calling at the port of Brisbane. Beside the amount shown in the table, about 20,000 tons are annually despatched by river from the North Ipswich district for bunker purposes, so that the demand for this purpose is seen to have fluctuated during the last five years between 140,000 and 170,000 tons annually. Probably another 30,000 tons is despatched from the North Ipswich district for various markets or in the form of coke, but the exact figures are not to hand.

TABLE II.—SHOWING CONSUMPTION IN VARIOUS INDUSTRIES OF COAL RAILED FROM THE IPSWICH DISTRICT FOR FIVE YEARS ENDING 1904.

(Figures supplied by the Commissioner for Railways.)

Year.	Railway Purposes.	Bunker.	Cargo.	Gas and Meat Works.	Totals.
	Tons.	Tons.	Tons.	Tons.	Tons.
1900	46,349	122,073	40,301	19,168	227,891
1901	50,173	147,025	42,068	9,282	248,548
1902	47,604	130,197	31,976	8,652	218,429
1903	48,046	127,011	60,034	7,502	242,553
1904	56,775	121,765	76,017	7,036	261,593

The establishment of smelting works to treat the iron ores of the Queensland coast seems to be the only industry that would be likely to give any prospect of a rapid expansion in the consumption of Ipswich coal. Several of the seams make first-rate coke, and the mines would be as conveniently situated as any others in Queensland for economical treatment of these ores. The metallurgical industries are the most lavish consumers of coal of any, and until some such industries are established in Southern Queensland no serious taxing of the coal resources of the Ipswich district need be feared. With the revival of trade consequent on better seasons, and the natural increase of shipping to be expected from a port like Brisbane, the demand for coal from the Ipswich district may be expected to gradually increase, and the present slackness of the trade disappear, while the low prices that may be looked for henceforth will probably prevent the opening up of new ventures, such as have caused a plethora of coal during the last five years.

II. LOCALITIES WORKED FOR COAL.

The majority of the mines are in two main districts. The most productive—the Bundamba district—supplies over three-fourths of the coal turned out from the field, and covers an area of about 12 square miles, lying mainly to the south of the Brisbane-to-Ipswich railway line, between Six-mile and Bundamba Creeks, and from three to eight miles east of Ipswich. It affords the main steaming coals loaded into bunkers at Brisbane and used by the Railway Department for locomotive purposes. The second important district lies to the north of the Bremer River, immediately north of the town of Ipswich, and has been worked over an area about three miles in length by one mile in breadth. Its seams furnish the whole of the coke manufactured on the field, but there are also some good steam, blacksmithing, and gas coals. Besides these two main districts, there are the more distant localities of Walloon, Rosewood, and Purga, lying to the west and south of Ipswich, and furnishing a coal of a distinct character. It is much richer in volatile hydrocarbons, and gives a much larger percentage of gas in the gasworks retorts, where it is chiefly consumed. Detailed mapping of the field has shown that these seams occur in much higher beds of the coal series than those containing the coals of North Ipswich and Bundamba, these beds having been brought down into their present position about Walloon and Purga by a folding over of the lower beds along an axis striking north-westerly across the field through the town of Ipswich.

III. TRANSPORT FACILITIES.

Most of the coal from the North Ipswich district comes down the Bremer and Brisbane Rivers in punts, the distance to the wharves in Brisbane being about 35 miles, and to deep water at Pinkenba about

45 miles. The coke is removed by the North Ipswich branch line through Ipswich to Brisbane, a distance of about 26 miles to the wharves.

The Bundamba district is served by several branch lines and short spurs from the main line. Of these the latest one finished goes south from Redbank Station, 15 miles from the wharves, and reaches the furthest point of the field in another seven miles. It loops on at this point with the old Swanbank line, starting south from Bundamba, 20 miles from the wharves, and tapping the western and southern portion of the district. The more remote mines at Walloon and Rosewood are situated near the main line to Toowoomba, distant 30 miles and 36 miles respectively from Brisbane; while that at Purga, on the branch line from Ipswich to Dugandan, is situate about 29 miles from the port.

IV. MAPPING OF THE FIELD.

1. GENERAL MAP OF THE COALFIELD.

The Ipswich Coalfield was first geologically mapped and reported on by the author in 1899. Map No. 2, accompanying that report, was on a scale of 20 chains to an inch, and embraced all the coal mines then working, except those at Purga and Walloon. In the North Ipswich district the outcrops of six seams (all of which had been worked to some extent) and of their accompanying beds of sandstone and shale were mapped in detail over an area some three miles in length along the outcrops of the seams on the northern side of the Bremer River by about a mile in breadth. In the Bundamba district the outcrops of seven known seams and their accompanying beds were shown as far as they could be traced over an area of about twelve square miles between Bundamba and Six-mile Creeks. These two districts are separated by a large area of basalt country between Bundamba Creek and Ipswich, and by the alluvial deposits along the bends of the Bremer River, and the relations between the two areas are thus obscured. Recent more particular study, however, has furnished a theory of their connection with each other, which shows a great probability of being approximately correct, and which has important economic bearings. This connection is shown on the general map of the field accompanying this report. The map is on a scale of one mile to an inch, and gives a clearer idea of the geological structure of the field and the connection between the different areas than the older map. On it is shown the probable trend of the outcrop of the highest seam of the Bundamba district (the Aberdare Seam) under the basalt and alluvium referred to above. Above this seam in the Bundamba district, and stretching round the southern edge of the basalt towards the south of Ipswich, is a great thickness of sandstones, which have not yet given signs of being coal-bearing, and which I have named the "Bundamba Grits," or unproductive series. The base of

this unproductive series crosses the outskirts of the town of Ipswich to the south of Denmark Hill, the fossiliferous shales and coals occupying the summit of that hill being apparently on the same horizon as the Aberdare Seam, while the underlying Four-foot Sandstone apparently crosses the northern slope of the hill where it is quarried at several points for gravel. The Cooneana Sandstone of the Bundamba district immediately underlying the lower seams of that district is apparently identical with a sandstone which stretches across the western portion of Ipswich from the quarries at the end of Harlin road past the back of the Grammar School, and is found again overlying the North Ipswich seams about Tivoli.

If this theory as to the position of the various beds be correct, it must follow that the coals of the North Ipswich district are on a lower horizon than those at Bundamba, being represented in their higher members by the coals and shales underlying the Cooneana Sandstone, which are the lowest beds exposed in the Bundamba district. They may, therefore, be expected to be found over a wide area in the centre of the latter district at no great distance from the surface.

The present mapping thus shows a lower productive series of beds, containing the coal seams of the North Ipswich and Bundamba districts, overlain further south by an unproductive series of sandy rocks, the highest members of which are not seen. These latter beds bound the extension of the former on the south from Goodna to Ipswich, thus limiting the area over which mining on these coals may be expected to extend in this direction. To the west of Ipswich these unproductive beds—and with them, of course, the underlying coal-bearing beds—are sharply bent over to the south-west over a north-westerly striking axis of folding, by which a still higher series of coal-bearing beds is brought in. These beds were first worked for coal at Walloon, and may be known as the "Walloon Beds," or upper productive series. They are also worked to some small extent at Rosewood and Purga, and apparently occupy the whole of the area of the map south-west of a line drawn from Yahmahnto, on the Fassifern line, to Borallon, on the Brisbane Valley line. They afford few exposures, consisting mainly of soft sandstone and clay shales, which have weathered to a generally level surface. The coals contained in them are quite distinct in character from those worked in the lower productive series about Ipswich and Bundamba, having a much greater content of volatile hydrocarbon and a different physical structure.

2. MAP OF THE BUNDAMBA DISTRICT.

In the North Ipswich district there has been little fresh development of importance since the writer's previous report. The production for 1904 was about 54,182 tons, as against 46,743 tons during 1898, these figures representing a drop from 16 per cent. of the total in the former year to 14 per cent. in the latter year. The number of producing

mines dropped from eight to five. In the Bundamba district, however, the opening up of a number of new pits to the south and east of the old established mines around Blackstone, Bundamba, and Dinmore led to a request for a more complete map of this district, which would show the relations of the seams opened out in these mines to the earlier worked and better known coals. Accordingly, this district was mapped again on a larger scale (viz., 10 chains to an inch), and the map has been extended to take in the whole of the area over which the productive series of the coal measures occur between Six-mile and Bundamba Creeks, these beds being covered to the east, south, and west by the overlying and unproductive Bundamba Grits.

In this map the positions of the main workings and their general trend is shown by shading. The workings thus shown have no pretensions to accuracy of detail, as it would have involved a much greater expenditure of time than seemed justified by the benefits to be gained to have brought all the workings up to date and accurately plotted them on the map. The detail shown is intended merely to indicate generally what areas have been worked to the greatest extent, and to bring out more clearly the trend of these seams across the field.

The topography of the district has been derived from various sources, and accuracy in detail is not here claimed. It is unfortunate that the Geological Survey has no officer on the staff who could be engaged solely in making topographical maps of important mineral areas, and the Ipswich Coalfield is a mineral area that deserves early attention in this respect. A topographical map of the field, properly contoured, and with surface features accurately delineated, would not only be of the utmost value to the geologist and prospector as an aid in locating and tracing seams, but would also be of service to every mine manager and proprietor interested in the coal-mining industry. The accompanying map gives as much of detail as could be gathered in the time that I found justified in expending on the work. The greater portion of the topography was compiled from maps and original survey plans in the Lands Office, but the Railway Survey Department also kindly lent important aid with details of railway and feature surveys of certain portions.

The detailed mapping of this district has, I think, allowed of a correct representation of the relation between the seams around Dinmore and New Chum with those of the rest of the field. This relation has hitherto been obscure. It will be explained later on in this report. The drawing in of the outcrops of the various seams over many areas as yet untouched should, I think, prove of some considerable assistance in future prospecting along these outcrops. The mapping has also served to show the limits of the area over which the coals of the Bundamba district can be expected to be found at workable depths, this area being limited to the east, south, and west by the depth to which the coals can be worked under the overlying unproductive Bundamba Grits.

V. GENERAL GEOLOGY OF THE TRIAS-JURA SYSTEM OF SOUTHERN QUEENSLAND.

AGE AND EXTENT OF THE BEDS.

The beds of the Ipswich Coalfield have furnished some seventy species of plants belonging to the natural orders Calamariæ, Filicæ, Cycadaceæ, and Coniferæ, by which they have been determined to be of triasso-jurassic age. They have also furnished one genus each of Crustacea, Insecta, and Lamellibranchiata.

Beds of similar lithological character, and furnishing here and there examples of the same flora, are met with over an area of about 30,000 square miles in the Moreton, Wide Bay, Burnett, and Darling Downs districts and in the southern portion of the Leichhardt district. An extensive area of these rocks stretches as a belt some 40 miles in width in the form of a crescent running from the heads of the Richmond and Clarence Rivers, in New South Wales, for a distance of some 300 miles in a north-westerly direction to the head of the Dawson Valley, in the Leichhardt district. Besides the mines of the Ipswich Coalfield, this belt contains numerous other seams of coal, which have been worked to some extent in the Walloon-Rosewood districts, and in several places on the Darling Downs, west of the Main Dividing Range.

South of the city of Brisbane this extensive belt is connected by a narrow neck of the same rocks with a second long strip which extends for about 300 miles along the coast from a little south of Brisbane to a little north of Bundaberg. The maximum width of this belt is about 40 miles. The coalmines of the Burrum Field lie in this coastal belt of the Trias-Jura. At Point Arkwright this belt is shown on the Geological Map of the colony to be broken by a tongue of older Palæozoic rocks, but in a paper read before the Linnean Society of New South Wales, entitled "The Geology of the Volcanic Area of the East Moreton and Wide Bay Districts," Mr. H. I. Jensen has recently stated that "there is no break between the Ipswich and Burrum Coal Measures, as the Geological Map of Queensland leads one to suppose."

Mr. Jack included all the beds north of Point Arkwright in his "Burrum Formation," the rocks south of that point and in the inland belt of Trias-Jura being included in a later "Ipswich Formation."

The Burrum Formation has as yet furnished only some ten or eleven species of plants, of which four occur in the Ipswich Beds, while all the genera are represented by allied species in the Upper Beds. In addition, two genera of lamellibranchs from the Burrum Beds have not as yet been found in the Ipswich Beds. In view of the distance between the places where these two formations have been mainly studied, and the paucity of the flora as yet found in the Burrum Beds, there does not seem to have been sufficient evidence for a separation of the Trias-Jura into two formations; and, in any case, the evidence

for considering the Burrum Beds as belonging to an earlier period of the Trias-Jura is not conclusive. The two formations have long been considered as identical in age by the Geological Survey, and the recent observations of Mr. Jensen lends confirmation to that conclusion.

GENERAL DISPOSITION OF THE TRIAS-JURA BEDS.

The Trias-Jura Beds along the coast between Brisbane and Bundaberg, and the larger inland belt in which the Ipswich and Darling Downs Coalfields lie, were laid down on a floor of highly-folded Palæozoic rocks, which have been intruded by plutonic rocks, mainly of a granitic type. These older rocks have subsequently been exposed over a wide area between the two belts of Trias-Jura by a gentle bending up of the earth's crust since their deposition. This area of bending runs, roughly, in a north-westerly direction from a few miles west of Brisbane. Subsequent denudation of the coastwise fall of the anticline thus formed has denuded off wide areas of Trias-Jura along the upper waters of the Burnett, Mary, and other coastal rivers. Numerous small isolated areas of Trias-Jura Beds are still found scattered along the crest of the broad anticline with varying gentle inclinations from the horizontal. These isolated areas have escaped the general denudation, and still give evidence of the once continuous occurrence of the Trias-Jura over the whole area.

As a consequence of this bending up of the Trias-Jura the beds of the coastal belt have a general east to north-east dip under the sea, while those of the inland belt have a general south-westerly to west-south-westerly dip under the overlying Cretaceous rocks of the Artesian Water System of the interior. The Cretaceous rocks succeed those of the Trias-Jura without any observable break or stratigraphical unconformity, but with a complete change from the terrestrial and estuarine flora of the latter to a fauna of marine mollusca and allied genera. The bending up of the Trias-Jura Beds becomes inappreciable in amount to the south of the Brisbane River, with the effect that these beds can here be traced right across the axis of the fold, thus forming the strip of Trias-Jura country south of Brisbane, which joins up the inland and coastal belts described above.

THE NORTHERN BOUNDARY OF THE IPSWICH COALFIELD.

The coal beds of the Ipswich Field are amongst the lowest of the Trias-Jura system exposed by the gentle bending of the strata above described, and by the denudation to which they have been subjected along the Brisbane and Bremer Valleys. They lie close to the junction with the Palæozoic rocks, along the crest of the broad anticline above described. The junction between the two systems here runs roughly east and west, and has been mapped in detail for some 30 miles along the course of the Brisbane River. Along this junction

a series of coarse conglomerates interbedded with some thin sandstones, and occasionally with thin layers of coal, has been exposed by a puckering up of the Trias-Jura Beds in the bending process above referred to and by the denudation of the overlying coal-bearing beds lying further to the south.

These conglomerates dip roughly to the south-east, and no doubt represent the basal beds of the Trias-Jura System. Along their northern boundary on the Brisbane River they abut against an irregular wall of the older Palæozoic rocks, and are no doubt the results of the destruction of an old coast of those rocks by an advancing sea or lake, in which the higher coal measure rocks were subsequently laid down. In the former report on the Ipswich Coalfield, this junction along the Brisbane River was assumed to be a faulted one, but on further consideration I am led to the opinion that it is merely an unconformable junction representing an old cliff face of the Trias-Jura period.

The relations between the two systems have been clearly exposed by the course of the Brisbane River, which has carved out its winding valley along the junction over a distance of some 30 miles. The area over which the conglomerates are exposed extends for a distance of about 10 miles along the junction, and is shown on the accompanying general map of the coalfield.

THE IPSWICH BEDS.

Overlying the basal conglomerate of the Trias-Jura System, and covering an area of about 50 square miles to the north and south of the Western railway line, between the towns of Goodna and Ipswich, are the coal measures proper of the North Ipswich and Bundamba mining districts. I have restricted the name "Ipswich Beds" to this stage of the Trias-Jura System, because it was these beds that were first worked and studied, and because it has become possible by recent study to distinguish them from the later coal measures of the same system which have been worked about Walloon.

The Ipswich Beds probably represent a thickness of some 2,500 ft. of sandstones and shales, with fourteen or fifteen interbedded coals, that have been worked at one time or another in the two districts abovenamed. These beds have been thrown into long gentle folds, with general maximum inclinations from the horizontal of about 15°. The area over which they have been exposed lies nearly on the crest of the Trias-Jura anticline, and the puckering up of the beds into the gentle folds just described has apparently been a minor effect of the general folding about the axis of that anticline. The subsequent planing down of the crests of these folds by surface denudation has exposed the outcrops of the seams, which it has thus been possible to trace in detail over a great portion of the coalfield.

South of the area of the coalfield the folding across the Trias-Jura anticline appears to decrease in amount, and the Ipswich Beds sink under the next succeeding stage of the Trias-Jura, which I have named the Bundamba Beds.

THE BUNDAMBA BEDS.

The Bundamba Beds succeed the Ipswich Beds conformably, and occupy the greater part of the south-eastern corner of the general map of the coalfield. They have, so far, proved unproductive, except for a small seam of about 1 ft. 6 in. near their base, which was formerly worked from the West Moreton shaft, south of Blackstone, and was known as the West Moreton Seam. Their base may conveniently be considered as lying about 70 ft. above the top seam (the Aberdare Seam) of the Ipswich Beds, and forms a generally easily recognised horizon of coarse grits and conglomerate, by means of which it has been possible to draw in the position of the outcrop of that seam throughout the field. The base of the Bundamba Grits, which thus gives a pretty good indication of the limits of the area over which the coals of the Ipswich Beds may be expected to be within workable distances of the surface, has not been traced further east than Goodna. Beyond that town it is overlain by more recent beds, possibly of Cretaceous Age, from which a rich flora of Dicotyledonous plants has been obtained. The Bundamba Beds consist of coarse grits and sandstones with thin interbedded finer strata.

MONOCLINAL FOLDING OF THE IPSWICH AND BUNDAMBA BEDS AND THEIR JUNCTION WITH THE WALLOON BEDS.

West of the town of Ipswich the lower series of the Trias-Jura just described have been sharply bent over an axis striking north-north-west and south-south-east, and disappear to the west under the softer sandstone shales and clays of the Walloon series. The Walloon Beds lie with only slight deviations from the horizontal, and cover a wide area in the Walloon, Rosewood, and Dugandan districts, where they have been worked for coal at several points. The upturned edges of the Bundamba Grits and Ipswich Coal Beds can be followed over a width of about a mile, and have been traced over a length of about five miles. The strike of the upturned edges of the beds is about north-west and the dip about 80° to the south-west.

Owing to the softer character of the strata of the Walloon Beds, and perhaps to their general horizontality, the country over which they lie to the west of Ipswich has been levelled down to a peneplain, through which the Bremer River meanders with a very slight fall in its course. As it crosses the harder sandstones of the Bundamba and

Ipswich Beds, however, its fall becomes much steeper, and is marked by rapids at several points about Ipswich, the country meanwhile becoming more hilly and the valley of the river more pronounced.

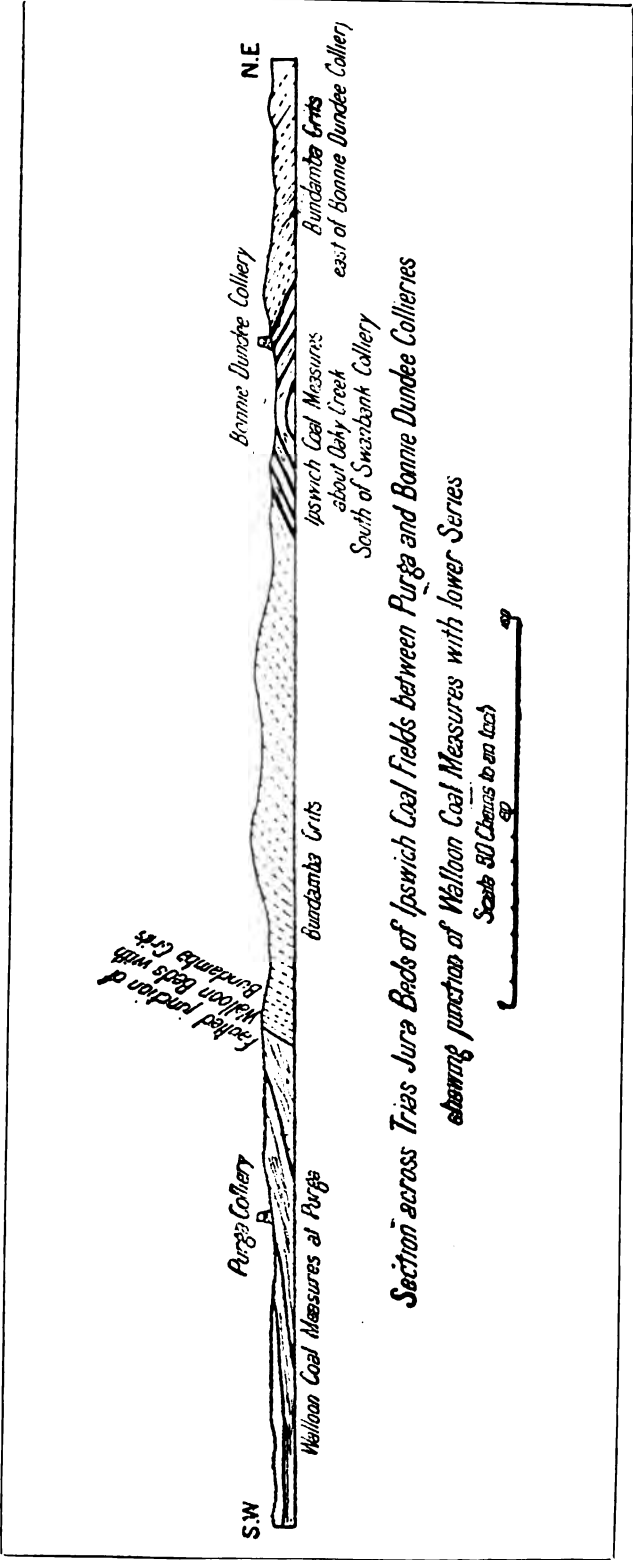
The level character of the country of the Walloon Beds, and the absence of any sections showing them in contact with the Bundamba series, prevent any clear exposition of the relation between the two series in the field. The general mapping, however, appears to me to lead to the conclusion that the Walloon Beds have been faulted down against the Bundamba Beds along a line running parallel with the axis of the sharp folding to which the latter have been subjected. Traced to the north, this line of junction, and probably of faulting, is cut off by the older Palaeozoic rocks, but is apparently continued on as a line of faulted junction between the Walloon Beds and the Palaeozoic rocks, with which they come here into direct contact. This probable continuation of the faulting is shown more clearly on Map No. 2 accompanying the first report on the Ipswich Coalfield.* The accompanying plate shows the relation between the Walloon and lower beds south of Ipswich.

There is also the possible explanation that this north-west striking line of junction first between the Walloon Beds and the Bundamba Beds, and then between the Walloon Beds and the older rocks, is an ordinary unconformable junction, representing a stratigraphical break within the Trias-Jura. In any case, there seems no doubt that the Walloon Beds belong to a much higher horizon of that series than the Ipswich and Bundamba Beds.

THE WALLOON BEDS.

The Walloon Beds have not as yet been studied in any detail. Indeed, the rarity of outcrops of rock over the level area to the west of Ipswich, and the absence of much mining or quarrying, precludes any very detailed study of the formation. What little we know of them, however, shows that they possess features which differentiate them from the coal-bearing beds of the Ipswich Field. The coals hitherto found show a characteristic choncoidal fracture in the hand specimen, burns readily with a long, luminous flame, and give off a much larger proportion of volatile hydrocarbons when heated in a closed vessel than do the brittle bituminous coals of the Ipswich Beds. It does not, however, seem possible to draw any distinction between the formations from palaeontological evidence, most of the fossils as yet found in the Walloon Beds occurring also in the Ipswich Beds.

* Geological Survey Publication, No. 147.



Section across Tries Jura Beds of Ipswich Coal Fields between Purga and Bonnie Dundee Collieries
showing junction of Walloon Coal Measures with lower Series

POSSIBLE DIVISION OF THE TRIAS-JURA SYSTEM INTO TWO STAGES.

The Walloon Beds thus, no doubt, lie on a considerably higher horizon of the Trias-Jura System than the beds about Ipswich. These latter have not been mapped in detail east of Goodna, but there is not wanting evidence that they are continuous to the east with the sandstone and associated coals which are now being prospected about Nundah, continuing thence along the coastal lands between Brisbane and Bundaberg, probably including all these beds, and among them the Burrum Formation.

All the inland belt of Trias-Jura rocks west of Ipswich, on the other hand, is characterised by coals similar in character to those found about Walloon, Rosewood, and Purga, and it seems extremely likely, notwithstanding the as yet negative results of the palaeontological evidence, that future more detailed study will impose upon us the necessity of considering the Trias-Jura system as divisible into two stages, an earlier represented by the beds of the Ipswich and Burrum Coalfields, and a later represented by the coalfields of Walloon, Purga, and the Darling Downs.

THE REDBANK PLAINS BEDS.

About the farming district of Redbank Plains there occurs an area of fissile shales which are seen to lie with a more or less distinct unconformity on the coarse grits and sandstones of the Bundamba Beds. They can be traced all round the southern margin of the beds of volcanic rocks, which give the chocolate soil of the plains, and have been sunk on in various shafts for wells along Six-mile Creek and on the farms in the south-eastern corner of this district. They have afforded some fragmentary fish remains and remains of Dicotyledonous plants, which latter circumstance points to a probable identity with the supposed Cretaceous beds found about Darra and Wolston. They appear to lie practically horizontally. Near Jones's Bee Farm they are accompanied by soft felspathic sandstones. A few yards further east the underlying grits of the Bundamba Beds are found lying with varying angles of dip of up to 30° from the horizontal, and give evidence of a more or less distinct unconformity with the overlying shales. The area covered by these presumably Cretaceous beds is shown in green on the map.

BASALTIC AND FELSITIC LAVA FLOWS.

Several large areas of these rocks are shown on the general map, as well as a few isolated patches, which seem to indicate a once almost continuous extension over the whole of this area. From the lighter colour of the soil about Redbank Plains and the more acid character of the weathered specimens of rock that were observed, it seems probable that the lavas in this area were more of the nature of andesite or trachyte, and they have consequently been mapped as felsitic in character as distinguished from the more basic basalts of the other portions.

Chapter II.—The Bundamba District.

I.—DETAILED GEOLOGY.

1. GENERAL DISPOSITION OF THE BEDS.

The productive coal measures in the Bundamba district consist of alternating conglomerates, grits, sandstones, and shales, with at least seven well-recognised beds of coal, six of which have been worked at one time or another. They are exposed to a depth of about 1,000 feet from their uppermost beds, the lower beds of the series not being exposed. They are overlain round the south-east, south, and south-west of the area shown on the map by the overlying unproductive series of grits and sandstones which I have called the Bundamba Grits, and have been brought up from beneath these beds by a bending up of the strata over an axis running in a north and south direction across the centre of the field. This bending of the strata forms an irregular anticlinal ridge, with an average maximum dip on either side of about 14° from the horizontal. The beds are thus exposed along their outcrops in descending order along the western side of the field, as it is traversed from west to east, and the same beds are again exposed in ascending order as the eastern side is crossed. The bending up has been most severe about the centre of the northern half of the field, so that the lowest beds are exposed here in the Cooneana Estate. They outcrop over an oval-shaped area, with its longer axis north and south, and with the succeeding higher beds running in duplicate down either side of the field. South of the area at present worked, the bending up of the beds decreases rapidly, and the outcrops of the upper coal beds can be traced round from one side of the field to the other.

The north-eastern corner of the district about Dinmore and New Chum is cut off from the rest of the field by a line of faulting (Stafford and Rhondda Faults on the map), which breaks the regularity of the line of outcrop in this direction. The beds are thrown down to the north-east by this faulting, so that they lie with only gentle inclination over an area of about a square mile and a-half round Dinmore and New Chum, between these faults and the Ebbw Vale Fault, which throws up the beds again to the north-east. The New Chum Seam has been worked by several vertical shafts between these two faults, and has been one of the most important producers of steam coal in the district.

Five years ago this seam was the most productive of any in the district, being pressed closely by the Aberdare Seam, worked at that time solely along the western dip of the measures in the neighbourhood of Blackstone. During the last five years numerous new pits have been opened along the southern extension of the Aberdare Seam beyond Blackstone, and also along the eastern fall of the beds towards Six-mile Creek; so that the Aberdare Seam is now by far the most productive of any in the Ipswich district.

Besides this new work on the Aberdare Seam, several new collieries have also been lately opened up, and prospecting work has been done on some of the lower seams in these directions—in one or two cases with considerable success.

The opening up of these collieries has thus shown the importance of these seams to the district, and has allowed of the mapping of their continuation to the south and east of the older established collieries with a much greater degree of accuracy than was possible five years ago. This has permitted of the identification and correlation of the seams in a much more satisfactory manner. There is still doubt as to the exact position in the series of some of the seams, but it is hoped that the new map will assist in the elucidation of these points in the near future.

The various horizons by which these seams can be traced will now be considered in detail in ascending order.

2. THE COONEANA SANDSTONE.

The lowest persistent bed that is exposed over any considerable area is a sandstone, which is shown on the map to outcrop over a roughly oval hollow area in the northern portion of the map on the Cooneana Estate, and is marked as the Cooneana Sandstone. This sandstone dips out in all directions from the centre, and must be about 100 feet in thickness. Below it is an area of shales, which show few exposures, but give signs of being coal-bearing. From reasons advanced later on, it seems probable that the Cooneana Sandstone is on about the same horizon as the thick bed of sandstone found overlying the Garden and Tantivy seams (the highest seams) in the North Ipswich district, in which case the underlying shales show every likelihood of containing seams of economical value. The Cooneana Sandstone is not exposed elsewhere on the field; but, in a bore put down from the bottom of the New Chum No. 3 shaft, Mr. Jeffries, the manager, tells me that, after passing through shales containing two lower seams, a considerable thickness of soft felspathic sandstone was passed through from 162 feet below the floor of the New Chum Seam. This sandstone I take to be the Cooneana Sandstone, lying, as it thus does, about 400 feet below the next succeeding and easily traceable bed of sandstone immediately above the Four-foot Seam, which I have called the Four-foot Sandstone.

3. THE BUNDAMBA SHALES AND LOWER COALS.

Between these two easily recognisable beds of sandstone is a series of about 400 feet of ferruginous shales, carrying the five lower seams of coal of this district, and several thin bands of soft flagstones. These shales weather to a rusty red soil, which generally gives a sufficient indication of the character of the rock being passed over. The coal seams, in ascending order, have been named Doby's, Rob Roy, Striped Bacon, Bergin's, and the Four-foot.

These seams were first worked near the township of Bundamba, in the north-western corner of the district; and the work extended along the outcrops of the seams in a southerly direction up the eastern side of Bundamba Creek. I have consequently called the beds in which these seams lie the Bundamba Shales. The workings along Bundamba Creek have, however, long been abandoned. In the Dinmore district the important New Chum Seam is one of this series, and has been worked continuously for a number of years. Recently several openings have been made, and two collieries started on seams belonging to this series on the southern and eastern extension of this outcrop beyond Blackstone and Cooneana. Of these, the Rhouda Colliery, on the eastern fall of the beds towards Six-mile Creek, has been the most successful; while in the new pit of the Aberdare Company, on the Four-foot seam, and in Wall's pit, probably on the continuation of Bergin's Seam, a considerable amount of prospecting has been done. Outside the Dinmore district and the Rhouda Colliery, however, but little coal is as yet being turned out from these seams.

On the southern portion of the Cooneana property these Bundamba shales and their accompanying coals dip under the Four-foot sandstone which immediately overlies them. They reappear again further south in the drainage basin of Oakey Creek, and are found over a considerable area where the coals have been exposed in a number of prospecting openings. Up to the present, however, the Swanbank Colliery Company is the only one which has worked them successfully, its operations on the two uppermost coals having been carried on continuously ever since the discovery of coal on the northern bank of Oakey Creek, about 1890.

4. THE FOUR-FOOT SANDSTONE.

The Four-foot sandstone, which is found overlying the Bundamba shales immediately above the Four-foot Seam, forms a readily traceable horizon, which has been mapped with a considerable degree of accuracy over the greater portion of the district. About Bundamba and Blackstone it is some 300 feet in thickness, but further south it decreases in thickness, till, between the Mafeking and Denham pits, it cannot be much more than 150 feet. Its outcrop can be traced round from the western side of the field to the Rhouda Colliery on the east, where it is displaced by the large fault (the Rhouda Fault) lying to the north-east of that colliery. It is again found in the Whitwood No. 3 shaft and on the road in the gullies to the south of that colliery. About the centre of the area mapped, south of the Cooneana Estate, this sandstone covers the lower Bundamba shales and lower coals over a considerable area to the east of the Bogside and Mafeking mines, stretching across the crest of the anticline from west to east. It has been brought down here by a slight troughing of the beds under an east and west axis of bending.

On the hill above the Swanbank Colliery this sandstone is intercalated with beds of coarse, pebbly conglomerate, which was formerly supposed by the writer to be a continuation of that overlying the Aberdare Seam about Blackstone, but which the detailed mapping, rendered possible by the opening of the collieries about Box Flat, and the prospecting work incidental to this work, has shown to be bent much further to the east over a north-westerly striking axis, passing through the Denham Colliery and the north-western levels from the Swanbank Mine. The conglomerate can be traced across to the south of Oakey Creek, and the sandstone still further followed in a sweeping circle round the southern portion of the map to where the underlying Four-foot Seam has been opened by several shallow shafts near the Bonnie Dundee railway line.

The Four-foot sandstone, with its accompanying pebbly conglomerate overlying the Swanbank Seams north of Oakey Creek, can be traced south across the creek, where the Swanbank No. 1 Seam was again opened out by two inclined slopes on portion 5, but with no very promising indications.

North-west from Swanbank the sandstone can be traced through portions 130, 134, and 135 to 147, on the northern end of which a shaft passed through the lower portion of the sandstone and exposed the Four-foot Seam. At this point the continuity of the beds seems to be broken by a fault, as a second shaft, a little further south, has not met either the sandstone or the coal. The sandstone is shifted further east, and its probable continuation from here round to portion 5 is only mapped in from its known relation to the overlying beds which have been followed round further south.

5. THE ABERDARE SHALES AND OVERLYING BUNDAMBA GRITS.

Above the Four-foot sandstone is another bed of shales about 100 feet in thickness, and containing two persistent seams of coal—one near the bottom, known as the Bluff seam, and the other near the top, known as the Aberdare Seam. The position of these shales can be traced most readily over the whole district by means of the overlying grits and sandstones, which form conspicuous outcrops marked by many ridges and abrupt escarpments. The Aberdare Seam, the most valuable in the district, was first worked under the conspicuous hill to the south of Blackstone, formed by the outcrop of these grits and coarser beds of conglomerate. It was the tracing of this series of coarse and hard beds to the south and east of Blackstone, and the consequent mapping of the underlying coal, which encouraged the opening up of the four new pits along the eastern margin of Box Flat, and the still more recently opened mines along the eastern fall of the beds near Six-mile Creek.

II.—THE SEAMS.

1. THE ABERDARE SEAM.

This seam is at present the most productive and most sought after seam in the district. Its yield increased from 31 per cent. of the total output of the district in 1899 to 55 per cent. in 1904, the output of the New Chum Seam, the second most productive, having dropped in the same time from 38 per cent. to 21.5 per cent. of the total. In 1898 the Aberdare Seam was worked in only two collieries—the Aberdare and West Moreton Collieries, situated on the western dip of the beds near Blackstone. Since then four new collieries have been opened up along the southern extension of the outcrop past Box Flat, the southernmost working being about $2\frac{1}{4}$ miles from the northernmost levels of the Aberdare Colliery. The shaded portions on the map show the positions of these workings, and roughly the extent to which the seam has been worked.

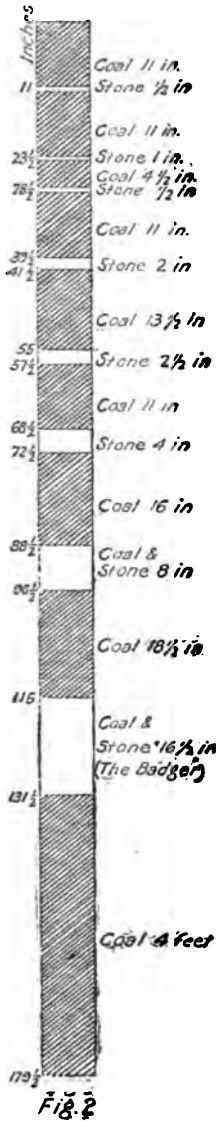
The Aberdare Seam has a good reputation as a steam coal, and has given high evaporative results wherever it has been tried. It produces very little clinker, and a relatively small proportion of ash.

Fig. 2 is a section of the seam, taken by myself, in Walker's Fairbank Colliery. This section shows about 11 feet of coal in about 14 feet of coal and bands, and is fairly representative of the character of the seam about Blackstone. As it is followed to the south, the lower section of 4 feet becomes thinner and of poorer quality, while in the Aberdare Mine, to the north, this section was worked 5 feet in height, over a large area. The seam is worked in two sections. In some cases a top section, down to the $68\frac{1}{2}$ -inch mark on the diagram, is taken down first, the bands of stone being picked out before filling. From the $68\frac{1}{2}$ -inch mark to the $96\frac{1}{2}$ -inch mark is then left as a roof above lower rooms, which are worked immediately underneath on the lower section from the $96\frac{1}{2}$ -inch mark to the bottom. In other cases, where the section below the stone, called the "badger" (shown on the figure), is poor, the first section is taken down to the $88\frac{1}{2}$ -inch mark in the figure. The 8-inch band of stone is then stripped by yardage, and the underlying $18\frac{1}{2}$ inches of coal lifted, the coal below the "badger" not being worked.

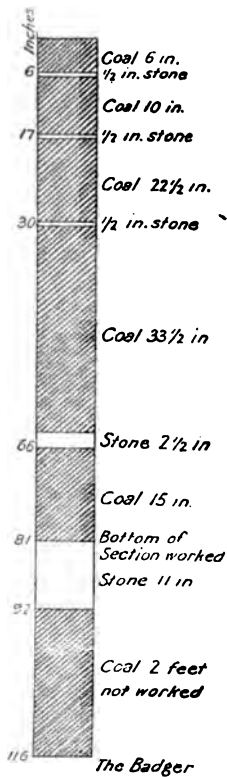
COLLIERIES ABOUT BLACKSTONE ON THE ABERDARE SEAM.

Aberdare, West Moreton, and Borehole Collieries.—The underground workings on the map show the extent to which this seam has been worked. The Aberdare Colliery was the first opened out on the seam, being started by Mr. Lewis Thomas, of Blackstone, on the shallow and easily-mined coal lying under Blackstone Hill. The contour of the ground throws the main outcrop back to the east of the hill, at the same time exposing the seam again as an oval-shaped line on the map on the western fall of the hill. From this outcrop drives

were put in to the rise of the coal and on this level, and the coal run out at a trifling expense on to a branch railway line coming up the gully that exposes the outcrop.



SECTION OF ABERDARE SEAM
IN WALKER'S FAIRBANK
COLLIERY, BOX FLAT.



SECTION OF ABERDARE SEAM
IN NEW WEST MORETON
COLLIERY.

The Aberdare Colliery still takes the lead in output of any colliery in the State, with a yearly production of about 60,000 tons. The workings now extend some 50 chains to the dip of the outcrop, and

20 chains from the dip of the No. 3 (or Coolgardie) shaft, from which the coal is now all mined. The No. 3 shaft is 523 feet deep, and the workings have been extended some 1,800 feet to the north. The grade is almost due west, at an angle of about 14 degrees, or 1 in 4. This has brought the bottom of the dip to a vertical depth of nearly 900 feet below the level of the shaft head, or 1,000 feet below the level of the ground above. Trouble with water has prevented further sinking of the dip. Most of the coal is being won from the levels going north from the dip from the No. 3 shaft. As they go north these levels bend round to the west, the dip of the coal swinging round till, under Silkstone, it is about south-south-west.

The importance of this fact is that the strike of the coal, which is obscured north of the village of Blackstone by the alluvium of Bundamba Creek, is thus proved to swing round under the basalt capping the coal measures here towards Booval Station, thus bringing the coal to within shallow depths along the Brisbane road, in close proximity to the railway line. The strike of the coal beds further west is shown to still curve round under the basalt, for, at the town of Ipswich, the strike is almost south-west, and the dip south-east towards Blackstone. Accordingly, the Aberdare Seam, which dips west under the basalt area in the Coolgardie Mine, must necessarily flatten as it is traced further to the dip, and rise again on the western side of the basalt under the town of Ipswich. The greatest depth in a line due west of the Coolgardie Mine cannot thus be much over 2,000 feet, and there must consequently be a considerable area of country within easy reach of the main line at Booval, under which it is probable that the Aberdare Seam exists in good quality, and nowhere at a greater depth than 2,000 feet.

The Aberdare Seam has also been worked over a considerable area to the south of Blackstone, from the Aberdare No. 2 and West Moreton shafts. The workings from the former shaft extended to a distance of about $\frac{1}{2}$ mile to the east of the shaft, the level course here swinging round to almost due east. The swinging round of the dip is clearly shown by the tracing of the underground levels on Map 2. The workings were blocked by a fault, and, owing to fires in the gob, they had to be abandoned. The West Moreton workings to the south also met with troubled ground, the coal being apparently thrown up to the south-west by a fault striking in a south-easterly direction across the drive to the south. An attempt was made to find the coal on the further side of this fault by sinking a second shaft (No. 2 shaft), the position of which is shown on the plan. Unfortunately for the promoters of this scheme, the position chosen lay in the centre of an altered dyke of igneous rock which here cuts through the coal; and, after 85 feet of sinking, the work was abandoned. These dykes are common to the district, and do not seriously affect the quality or position of the coals; so that, had a position been

chosen a little to the east or west of the dyke, in all probability the seam would have been struck at no great depth, and a large area of land have thus been opened up successfully. This failure led to the seeking of coal lands elsewhere, and ultimately to the tracing of the seam round the eastern side of Box Flat, as shown hereafter.

North of the village of Blackstone, the Borehole Colliery also worked the Aberdare Seam, by means of a shallow shaft and stope. This colliery has been opened up again lately, having been idle for many years. It is not yet on the list of steady producers.

COLLIERIES ABOUT BOX FLAT ON THE ABERDARE SEAM.

Fairbank, Box Flat, Bog Side, and Mafeking Pits.—Since the date of the writer's last report (1899) these four collieries have been successfully opened up on the southern extension of the Aberdare Seam across the level country of Box Flat. They extend over a length of about 1 mile along the outcrop. Being situated close to an already existing railway line, and starting on the outcrop of a thick seam of coal of good quality, they have been able to mine large quantities at very cheap rates, and have thus been able to compete successfully against the older-established mines with their handicaps of long underground haulages. Their success has demonstrated the continuation of the Aberdare Seam, with little deterioration of quality or thickness, over a large area which was virgin ground at the time of the writer's previous report on the field. In that report the probability of the extension of the Aberdare Seam under the whole of the area embraced by Box Flat and the ridges lying immediately to the north-east was pointed out, and the probable position of the outcrop was drawn in on the accompanying map. The results obtained by these four collieries during late years is a striking example of the advantage of having coal at shallow depths. During last year the four pits, out of a total of twenty producers, secured over 37 per cent. of the trade.

As yet little more than the coal within a few chains from the outcrop has been extracted, though, owing to the steep dip of the beds, the coal is rapidly being carried to depths which are, in some instances, making trouble for the light hauling appliances installed for shallow working along the outcrop. The area of ground underlain by the Aberdare Seam to the east of Bundamba Creek, in this locality, is bounded on the north by the old Aberdare workings, and on the south by a bending-up of the beds, which rapidly throws the outcrop of the seam out to the west between the Mafeking and Swanbank Mines. The Box Flat Colliery, which includes the greater portion of the deeper ground over this area, has commenced deeper mining by sinking a vertical shaft, 405 feet in depth, about 16 chains from the outcrop, and has installed a winding-plant capable of dealing with a considerable output. This colliery also has lately installed the first coal-cutting machine employed on this field.

The levels from the bottom of the shaft show a flattening dip going north, and a steepening dip going south. The flattening of the dip going north should bring the coal to shallow depths over a large area between the Box Flat workings and the Aberdare No. 2 workings, and over the south-eastern corner of portion 286. The amount of ground still untouched here and at a depth of less than 400 feet should not be less than 100 acres. The probability is that the Aberdare Seam is nowhere more than 700 feet in depth to the east of the Swanbank Railway Line, which should give about Box Flat an area of coal still untouched, and at a less depth than 700 feet, of over 260 acres.

CONTINUATION OF THE ABERDARE SEAM SOUTH OF BOX FLAT.

The Mafeking pit of the Swanbank Collieries Company, towards the southern end of Box Flat, is the furthest southern working on the Aberdare Seam. The mine consists of a slope driven nearly due west on the dip of the seam for a distance of about 350 yards. The level going south met a fault at about 200 yards south of the main dip, which cuts off the coal and has thrown it up a vertical distance of about 100 feet, bringing the next lower seam—the Bluff Seam—into juxtaposition with the Aberdare in one of the levels. South of this fault the coal has been lately picked up by Mr. Harris, the manager, in prospecting workings on the northern slope of Mafeking Hill, and the outcrop has been traced over the brow of the hill on to its eastern and southern slopes. In this locality the strike of the coal has been changed, as mentioned above, by a bending up of the strata over a north-westerly running axis of folding, so that the dip has been altered to a direction a few degrees west of north, and the continuation of the line of outcrop is thrown round into a westerly direction. The line of outcrop is further deflected, as it is followed down the slope of the hill, by the lowering of the ground into a direction north of west. Beyond this point the continuation of the line of outcrop is uncertain. The bending back of the beds, however, over the north-westerly axis above referred to, which is evidenced by the workings on the lower seams in the Denham and Swanbank Collieries, should bring the coal back into about the position indicated by the broken line on the map. This area of ground is covered by the alluvium of Budadamba Creek, under which the outcrops of the seam and that of the overlying beds of sandstone are hidden, so that its position cannot be indicated with any degree of certainty.

The overlying beds of grit and sandstones usually found above this seam are again observed along the eastern side of Ivory's Lagoon, and can be traced by numerous outcrops in a half circle round the extreme south of the map.

On the heads of Oakey Creek Mr. W. Binnie recently opened a shaft, which I have no doubt is on the same seam. The seam is over-

lain by a thick mass of sandstone, which is passed over in a traverse further up the creek, and can without doubt be traced continuously to the known outcrops of the seam both to the north and west.

Mr. Binnie informs me that he found no workable section of coal in this seam, and this fact is decidedly disappointing, if the shaft proves, as I have no doubt it will, to be on the continuation of the Aberdare Seam. It shows that in the locality of this shaft, at any rate, this excellent seam has deteriorated so much in quality and thickness as to be unworkable.

NEW COLLIERIES ON THE EASTERN FALL OF THE ABERDARE SEAM.

The Bonnie Dundee, New West Moreton, and Fernie Creek Mines.

—The grits and conglomerate overlying the Aberdare Seam are again found along the western side of Six-mile Creek, from the heads of Oakey Creek to the mouth of Fernie Creek, forming a series of rough stony ridges. The Aberdare Seam has been opened up by three new collieries along the western slope of these ridges. The Bonnie Dundee Colliery lies on one of the heads of Oakey Creek, and the New West Moreton and Fernie Creek Collieries near the heads of Fernie Creek. These mines are served by the newly-opened continuation of the old Swanbank Railway Line in the case of the Bonnie Dundee, and by a branch line from the Bundamba loop-line in the case of the other two mines.

In the *Bonnie Dundee Mine*, the thickness of workable coal has decreased considerably from that in the mines on the western fall of the beds, but the seam has not been sufficiently opened up to allow of a proper estimate of its value being formed. The height of the coal being worked varies from 4 feet 8 inches to 5 feet, with two small bands 6 inches from the bottom. From the top of the seam to the bottom of the overlying sandstone are about 8 feet of unworkable coal and stone bands. This seems to indicate that the Bonnie Dundee Seam represents the upper portion of the Aberdare Seam, the lower portion being absent.

The overlying sandstones and grits above the Aberdare Seam can be traced in a northerly direction from the Bonnie Dundee Mine to the *New West Moreton* Colliery, where the seam has been opened out by two slopes on the dip of the seam and a drive along the course of the seam under Black's Hill. Fig. 3 is a section of the seam measured in the face of the rooms driven to the rise of this level.

This section corresponds with that of the Aberdare Seam above the "badger" stone in the Bog Side and Fairbank Collieries on the western side of the field, except that the bands of stone are thinner, and the

total thickness about 6 inches less. The 2 feet of coal at the bottom of the section is not worked, and the coal below the "badger" is not exposed, being on this side of the field too rough to work.

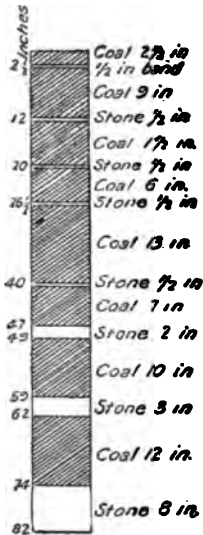


Fig 4

SECTION OF ABERDARE
SEAM IN FERNIE
CREEK COLLIERY.

In the No. 2 slope the whole section of the seam has been exposed, and it shows the section of the coal below the "badger" to be about 2 feet 2 inches in thickness, whereas on the western side about Box Flat this section of coal runs from 3 feet to 4 feet, and in the Aberdare Colliery was worked over large areas to a thickness of 5 feet.

The *Fernie Creek Colliery* has recently been opened on the Aberdare Seam, about 20 chains north of the New West Moreton Mine, and is fed by a branch line from the railway to that mine. The seam outcropped on the western fall of a steep spur, formed by the overlying grits and conglomerate, and has been opened by a slope driven almost due east along the dip of the seam, which is here about 14 degrees. Fig. 4 is a section of the coal worked, and evidently represents the top section of the Aberdare Seam. The bottom section is said to be wanting entirely.

CONTINUATION OF THE ABERDARE SEAM NORTHERLY FROM
FERNIE CREEK MINE.

The sandstones and grits overlying the Aberdare Seam at Fernie Creek can be traced across the eastern part of portions 286 and 283 and the Redbank Plains road to the north-western corner of portion 282. At this point a vertical shaft has been sunk under the sandstone to a

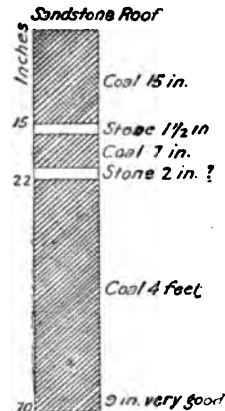


Fig. 5

SECTION OF FOUR-FOOT SEAM
IN SLOPE OPENING NEAR
WALKER'S FAIRBANK COL-
LIERY.

depth of about 200 feet, but no workable section of coal was found. Apparently the Aberdare Seam has deteriorated in this direction into nothing but coaly shales. Whether it makes again into good coal east of Six-Mile Creek is still unproved. Geological considerations point to the inference that it is represented further east by the uppermost seam worked under the sandstones of Goodna and Redbank; and if this is the case it does not return to anything like the same quality and thickness possessed by it in the Bundamba district.

2. THE BLUFF SEAM.

This seam has not yet afforded a workable section of coal in any portion of the field, though it has been exposed by prospecting shafts and drives at numerous points over the Bundamba district. It has been possible, by means of these prospecting workings, to map the outcrop of the seam over the greater part of this district. A recent measurement (made by Mr. Harris, manager of the Swanbank Collieries) of the seam as disclosed by a shaft sunk near the Mafeking Pit, shows about 20 feet of bands of stone and coal, the thickest clean band of coal being about 2 feet 1 inch of inferior quality, and no workable section being present. The seam apparently maintains this character over the greater portion of the district.

3. THE FOUR-FOOT SEAM.

This seam can generally be easily identified over the greater portion of the district from the fact that it lies immediately under the first thick bed of sandstone under the Aberdare seam. It generally shows about 4 feet of clean coal at the bottom, with two bands of white stone (divided by a thin band of coal, making about 7 inches in thickness) above, and separating it from another 15 inches of top coal. Between this top coal and the overlying sandstone there is often a foot or so of shale, but in many places the top coal is immediately overlain by the sandstone.

The seam was originally worked on the eastern bank of Bundamba Creek, between Bundamba and Blackstone, in the old Rosehill, Borehole, and Braeside Collieries, in workings long since abandoned. It has recently been opened up by the Aberdare Company immediately to the south of Blackstone by a slope on the dip, about 100 yards in length. The seam here shows about 9 inches of good coal at the bottom, and then about 1 foot 6 inches of rather rough coal, which is difficult to separate in working, and causes a good deal of trouble. The seam can be traced to the south by the overlying sandstone, past a slope put in by Walker Bros. on portion 295, and another put in by Messrs. Auld and Co., on the north-western corner of portion 286, to the ridge crossed by the loop-line between Wall's Mine and New West Moreton branch line. The coal was opened out on the top of the ridge, and again immediately east of the branch line. None of these positions have, however, been developed for producing coal. The section

of the seam shown in Fig. 5, and given me by Messrs. Walker Bros., from the opening on their ground, is fairly representative of its character.

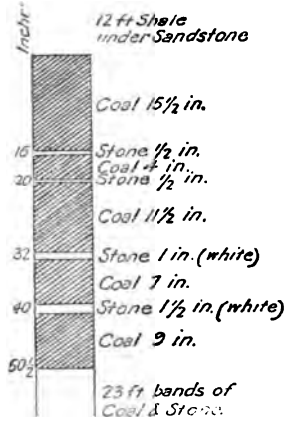


Fig. 6

SECTION OF BERGIN'S SEAM IN SHAFT
SUNK BY WALKER BROTHERS ON
PORTION 295.

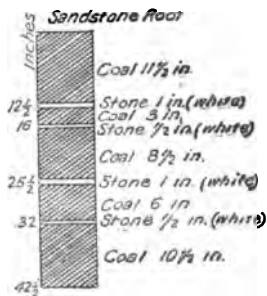


Fig. 8

SECTION OF SWANBANK NO. 1 SEAM
IN SWANBANK COLLIERY, AS
GIVEN BY THE LATE MANAGER
(MR. WOOLLEY).

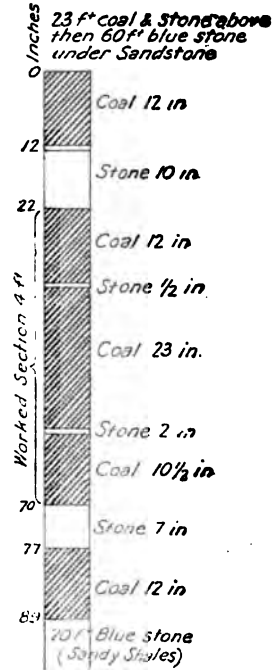


Fig. 7

SECTION OF RHONDDA SEAM
IN RHONDDA COLLIERY.

CONTINUATION OF THE FOUR-FOOT SEAM NORTH OF FERNIE CREEK.

The thick bed of sandstone overlying the Four-foot Seam can be traced across the Redbank Plains road, through portions 281 and 283 to the Rhondda Colliery, where the underlying coal has been exposed by three prospecting holes. In the north-eastern corner of portion 273 a fault has been disclosed by prospecting operations in a gully. This fault apparently cuts off the coal to the north-east, throwing it down in that direction, as shown on the map. This fault can be traced by

exposures in the gullies through portions 275, 270, 271, and 267, where it joins Gilliver's cutting fault coming through the Whitwood workings. In these portions the sandstone is brought down to the north-east by the fault, and it has been pierced by the Whitwood No. 3 shaft on portion 267 for a depth of 30 feet. Below this depth the shaft passed through coaly shales, which are apparently all the traces left of the Four-foot Seam in this direction.

SEAMS BELOW THE FOUR-FOOT SEAM.

The well-defined belt of shales and coal, which I have called the Bundamba Shales, contain, besides the Four-foot Seam at their top, four other seams, all of which were worked to some extent along the western fall of the bed between Bundamba and Blackstone. These workings have all been abandoned for some years. Lately, two new collieries have been opened up on coals occurring in these beds on their eastern fall towards Six-mile Creek.

4. BERGIN'S SEAM.

This seam was first worked by Bergin on portion 161, east of Bundamba Creek, and subsequently by Lindsay Bros., on portion 159. It was also, I believe, worked on portions 163 and 164. These workings have long since been abandoned. Walker Bros. have sunk a shaft on the same seam, on portion 295, in which I measured the section shown in Fig. 6. Below the bottom layer of coal are, according to Mr. Walker, senior, another 23 feet of coal and stone bands.

A seam of coal has recently been opened up in Wall's Mine, which I estimate to be about 70 feet below the Four-foot Sandstone, and which, consequently, corresponds in position to Bergin's Seam. At the top is about 4 feet 6 inches of coal, with bands of stone, which apparently corresponds with the seam at the top of Walker's shaft. Below this are 26 feet of coal and stone, which corresponds with that underneath the coal in Walker's shaft. At the bottom is 11 inches of coal, separated by 5 inches of thin shale from another 2 feet of coal. This latter section forms the main section of coal worked in Wall's Mine. Below this seam is about 3 feet 6 inches of blue shale, and then 3 feet 5 inches of coal, with three bands of stone, which forms the lower seam of Wall's workings. The continuation of this seam round to the north-east is shown on the map, and if it keeps at the same distance below the Four-foot Seam, its outcrop should pass a few yards east of the Rhondda shaft on portion 276.

5. THE STRIPED BACON AND RHONDDA SEAMS.

The Striped Bacon Seam was also worked by Lindsay Bros. on portions 245 and 159, near Bundamba, and was also opened up further south on portion 161, and in the Borehole property on portion 173; but these workings have long since been abandoned. From the position of the Rhondda Seam, below the Four-foot Sandstone in the

Rhondda Colliery, I judge the seam worked there to be the same, though the matter can hardly be considered quite certain.

Fig. 7 is a section of the Rhondda Seam. In this case 23 feet of coal and stone bands, under a thin sandstone, were passed through before reaching a workable section near the bottom. The coal is of good quality, and the colliery has advanced rapidly into the front rank as a producer. As shown later, this seam is probably identical with the New Chum Seam, which has been proved of such great value in the Dinmore district, and has proved that the latter seam continues in this direction in good quality, thus opening up possibilities of a large area of ground carrying this seam to the south of the Dinmore Fault. The Rhondda Colliery is served by a branch line from the Bundamba loop.

6. THE SWANBANK SEAMS.

THE NO. 1 SEAM.

The Four-foot sandstone overlying the Four-foot Seam, where it was opened out by Walker Bros. and Auld and Co. on portions 295 and 286 respectively, can be traced round to the east of the Mafeking Mine, as far as the south-eastern corner of portion 19. It is here bent up over the same north-westerly running anticlinal axis as the seams above it. This gives it a south-westerly strike across the head of the gullies on the northern end of portion 12, and brings it on to portion 13, where it changes to a coarse pebbly conglomerate, forming a steep escarpment along the eastern boundary of that portion. The Swanbank Seams crop out under this escarpment, the No. 1 seam of the Swanbank Mine lying immediately below the conglomerate bed. I therefore judge this seam to be the continuation of the Four-foot Seam.

Fig. 8 is a section of the seam as it was worked in the Swanbank Colliery. In this locality the Four-foot Seam appears to have decreased considerably in thickness, showing only 42 inches, in place of 70 inches of stone and coal. The top coal has decreased from 15 to 11 inches, but the two white stone bands, separated by a band of coal, are still present. The bottom coal has decreased to 26½ inches, and shows two distinct bands of stone about the middle. In spite of these differences, however, the fact that the seam lies immediately under a sandstone roof, which can be traced right round from the slope of the Aberdare Company on the Four-foot Seam past Walker's slope opening to the Swanbank Mine, leaves little doubt in my mind that the No. 1 Swanbank Seam is a continuation of the Four-foot Seam. The seam has been very little worked in the Swanbank Colliery.

THE SWANBANK NO. 2 SEAM.

This seam lies about 67 feet below the No. 1 Seam in the Swanbank Colliery, and thus corresponds pretty well in position with that known as Bergin's Seam about Blackstone. The seam here is characterised by about 4 feet 6 inches of coal under a shale roof, and is

separated from a lower section, running from 2 feet 6 inches to 3 feet 3 inches in thickness by 1 foot to 18 inches of shale. Below this again are bands of shale and coal, which, however, have not as yet afforded workable coal. This seam has been worked over a considerable area in the Swanbank Mine, on the south-western dip of the beds north of Oakey Creek. These workings have been abandoned, but the seam has again been opened out under the west of Swanbank Hill by a drive in through the overlying conglomerate to meet the seam, and a slope on the seam towards the north east. This is the Denham Colliery. The slope at first went about half-course, the dip being nearly due west. As it went further down, however, the dip swung round till, at the bottom, where the slope has been turned almost due north, it is following down the dip of the seam. This shows that the strike of the Swanbank seams is here almost east and west, and must necessarily bring their outcrops considerably to the east of Mafeking Hill. The Denham slope, in fact, crosses over the crest of the area of folding shown on the plan, and at once gives an insight into the relations between these seams and that worked in the Mafeking Tunnel.

7. PERKINS' SEAM.

This seam has been exposed by a cutting into the eastern face of Swanbank Hill, on portion 12. It is apparently about 130 feet below the Swanbank No. 2 Seam, and this distance agrees well with the distance between Bergin's and the Striped Bacon Seams about Blackstone. I have no doubt that Perkins' Seam is the continuation of the latter. The seam does not show any workable section in the cutting mentioned above.

8. THE DINMORE SEAMS.

COMPARISON WITH BUNDAMBA SEAMS.

As shown in the section treating of the general disposition of the Bundamba Beds, the north-eastern corner of this district is separated from the larger portion by a fault of considerable magnitude (the Dinmore Fault), which throws down the beds about Dinmore into a gently inclined position over a considerable area. In this area the New Chum Seam has been worked from a number of vertical shafts in the Whitwood, Dinmore, New Chum, and Ebbw Vale Mines. The extension of the workings to the north-east is again limited by a roughly parallel fault in the two latter mines, known as the Ebbw Vale Fault. The fall of the ground towards Six-mile Creek causes the New Chum Seam to crop to the surface in the gullies draining east into this creek. It was by drives into these outcrops that this seam was first worked, the workings gradually extending to the west and south and north. The relation between the New Chum Seam and those lying on the west of the field has long been a matter of conjecture, but recent work on the area has, I think, settled the matter with a considerable degree of certainty. A second fault, lying between the two main faults, but striking in a more easterly direction, and with a

strong up-throw to the south, brings the coal to the surface south of the old New Chum workings, and exposes it in a gully on portion 268. At this point the seam was formerly worked by a slope running towards the southern corner of the portion, but the workings have been abandoned for a number of years. In order to work the coal lying to the west of these workings on portions 267, 270, and 271, Messrs. Stafford Bros. have recently sunk a vertical shaft on portion 267. This shaft cut through the bottom coal of the New Chum Seam, at a depth of 245 feet. The seam dips south at an angle of about 1 in 6. For the first 30 feet the shaft passed through sandstone, which can be seen outcropping on the surface further south, and which I take to be the Four-foot Sandstone, and which is traceable, with little possibility of error, right round through the Cooneana property from the Blackstone side. Below this sandstone were about 70 feet of shales. Immediately below the sandstone should lie the Four-foot Seam, but I understand that it was represented here by a few feet of coaly shale.

At the bottom of the 70 feet of shale was the old Aberdare Seam, which has been opened up by a slope on portion 268, and is characterised by about 7 feet of coal with thin bands of stone, underlain by about 30 feet of coal and stone bands. The position of this coal in shales about 70 feet below the Four-foot Sandstone, and, showing a section of about 37 feet of coal and stone, corresponds very well with the position of Bergin's Seam, as opened by Messrs. Walker Bros. on portion 295, and I have no doubt that it is the same seam.

About 125 feet below the old Aberdare Seam—i.e., at a depth of 218 feet—the top coal of the New Chum Seam was met with, and the floor of the bottom coal cut at 245 feet. This makes a distance of 116 feet between the floor of the old Aberdare and the floor of the New Chum No. 1 Seams. Taking, for the moment, the old Aberdare Seam as identical with Bergin's Seam of the Blackstone area, the New Chum No. 1 Seam should be identical with the Striped Bacon Seam of the same area. The distances between Bergin's Seam and the Striped Bacon, as estimated by myself from the shafts sunk on the two seams by Messrs. Walker Bros. on portion 295, near the Fairbank Colliery, is about 128 feet; so that the distance between the two seams in the Whitwood No. 3 shaft corresponds very closely with that between the two seams at Blackstone. There seems to me very little doubt that these seams are identical each with the other.

In the Braeside Colliery shaft at Bundamba the distance between Bergin's and the Striped Bacon Seams was given to me as 100 feet. In the New Chum No. 3 shaft there is about 14 feet of coal and stone bands between the New Chum bottom and top seams, and about 40 feet in all of coal measures; whereas at Bundamba a third seam—the Rob Roy—is said to occur 30 feet below the Striped Bacon, so that it seems probable that these coal measures, in which these two

seams occur at Bundamba, are represented by the 40 feet of coal measures containing the New Chum Seams at Dinmore, the workable sections of coal at one place not occurring in exactly the same part of the section in the two localities.

The New Chum No. 2 Seam, with about 5 feet of coal, was found by boring by Mr. Jeffries, manager of the New Chum Mine, 74 feet below the New Chum bottom coal, and the New Chum No. 3 another 68 feet below. The former apparently has no representative worked on the Bundamba side, but the latter corresponds in position with the Braeside hard coal found in the Braeside shaft at about 147 feet below the Rob Roy. About 30 feet below the New Chum No. 3 Seam a soft felspathic sandstone was entered. I take this sandstone to be identical with the Cooneana Sandstone mapped over the western and southern portions of the field below the "Bundamba Shales."

9. THE NEW CHUM SEAM.

The bottom coal of the New Chum No. 1 Seam, generally known as the New Chum Seam, is the only one that has been extensively worked in this district. The section worked shows from 3 feet 8 inches to 5 feet of clean coal, separated by two bands of white stone with coal between, from about 15 inches of coal above. This section resembles very closely that of the Four-foot Seam about Blackstone, and the two have often been supposed to be identical. The fact, however, that the latter seam lies immediately below the Four-foot Sandstone, while the New Chum Seam has about 20 feet of coal and stone, with 8 feet of coal of the top seam above it, and then 180 feet of shales, in which occurs the old Aberdare Seam above that, proves conclusively that there can be no connection between the two. The New Chum Seam has supplied a large proportion of the coal for steam purposes from the Ipswich district for a number of years, its output during 1904 being 21.5 per cent. of the total production of the district. The shading on Map I. shows the extent to which this seam has been mined.

III.—FUTURE PROSPECTS OF THE BUNDAMBA DISTRICT.

Ninety per cent. of the output of the Ipswich district for 1904 was maintained by thirteen collieries, there being twenty-one mines in all on the producing list. This gives an average of 27,000 tons per colliery per annum for the most important collieries, or about 90 tons per working day. The premier position for many years has been held by the Aberdare Colliery, which last year again headed the list, with an output of nearly 60,000 tons, an average of 200 tons per working day.

It will thus be seen that in no case can the output be considered large enough to allow of economical working of the seams at any considerable depth, the number of separately managed collieries being greatly in excess of the requirements of the trade. The output of most

of them is thus rendered fitful, and necessitates their lying idle for many working days of the year.

The competition of the last five years has led to a gradual reduction of prices, from an average of 7s. 11½d. at the pit's mouth in 1899 to 5s. 11¼d. in 1904. Notwithstanding this great reduction in prices, most of the newer collieries have been able to open up their properties profitably, and have secured a large proportion of the trade. Thus the four new pits along the Aberdare Seam south of Blackstone produced in 1904 over 37 per cent. of the total output. Their operations have, I understand, been generally profitable, notwithstanding the initial expense involved in building spur lines to their pit mouths, and the erection of pit-head frames and haulage gear, and the greatly reduced prices of the coal. This has no doubt been possible by reason of the large quantities of cheaply workable coal provided by the outcrop of such a thick seam. The reduction in cost of coal to the consumer, though pressing hardly on operators accustomed to higher prices, was absolutely necessary in face of the keener competition of southern coal, induced by the general lowering of price there, and the removal of the import duty since federation. An average cost at the mines of 5s. 11¼d. per ton should prove sufficiently remunerative in the shallow workings of the Ipswich district were output continuous, and were the expenses of development and management not multiplied amongst so many small mines lying close alongside of each other, and often workable from the same opening.

As shown before, the chief hope of increased demand at present is that of a constantly enlarging shipping trade at the port of Brisbane. In this connection the extension of the run of the ocean liners of the Orient Company and their announced intention of making a trial of Ipswich coal are hopeful features. A few such regular customers, with facilities for rapid loading, would soon lead to a revival of trade, and put the industry on a more satisfactory footing. With the prospect of an expanding oversea trade from Southern Queensland, this field, situated as it is within a few miles of the port, and with large areas of cheaply-mined coal of good quality still untouched, should have a future of steady prosperity before it.

The Aberdare Seam at the present time furnishes nearly 58 per cent. of the total production of the field, two-thirds of its total coming from the four mines about Box Flat; another 21½ per cent. is derived from the New Chum Seam; so that these two seams furnish the bulk of the coal of the district. This circumstance is due to the fact that these seams are of first-rate quality for ordinary steam purposes, and on account of their both affording a considerable thickness of clean coal, they can be economically mined. Any immediate expansion of demand will, therefore, be probably met by increased drafts on these seams.

As shown before, the workings on the New Chum Seam have hitherto been confined to the ground immediately to the south and west of Dinmore. Recently, however, work has been extended to the west by the opening up of the Whitwood No. 2 shaft to the north of the railway line, and to the south by the Whitwood No. 3 and Rhondda shafts. In the latter direction the finding of the seam in good workable condition in the Rhondda Mine has opened up the probability of the existence over a large area of workable ground in the south-western corner of the field, none of which has as yet been prospected for this valuable seam of coal. Indeed, round the whole of the southern portion of the Cooneana Estate this seam has, as yet, not been prospected, its importance in this area having been overshadowed by the still more valuable and more easily traced Aberdare Seam, lately opened up in the collieries about Box Flat and at the head of Fernie Creek.

The outcrop of the Aberdare Seam, as shown on the map, runs down each side of the field in a roughly U-shaped line, the workings, as yet, all being north of the east and west road up Oakey Creek. To the north-west the country around Booval yet remains to be developed, while the northern extension along the eastern limb seems to be bounded by an area of poor coal as the outcrop approaches Six-mile Creek.

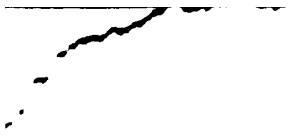
As previously shown, there is still a large area of country with coal at shallow depths east of the Swanbank line about Box Flat, while further south the outcrop of the seam has yet to be prospected over a long line extending up the flats of Bundamba Creek and round the southern portion of the map.

South of the Bonnie Dundee Mine no prospecting, except the shaft sunk by Mr. Binnie on portion 152, has as yet been undertaken; so that there is possibly a large area of shallow-lying coal along the outcrop here yet to be exploited, though the poor prospects found in this shaft are not very promising for this neighbourhood.

Besides these two seams of first-rate importance are the intermediate seams represented by the Four-foot and Bergin's Seams, which also contain valuable sections of coal in certain areas, and which have been worked with some success at detached points.

It is thus certain that the resources of the area embraced by the general map will be sufficient to meet any increase likely to occur in the demand for some years.

Brisbane, 30th September, 1905.



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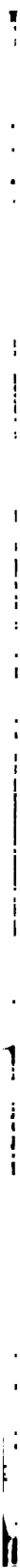
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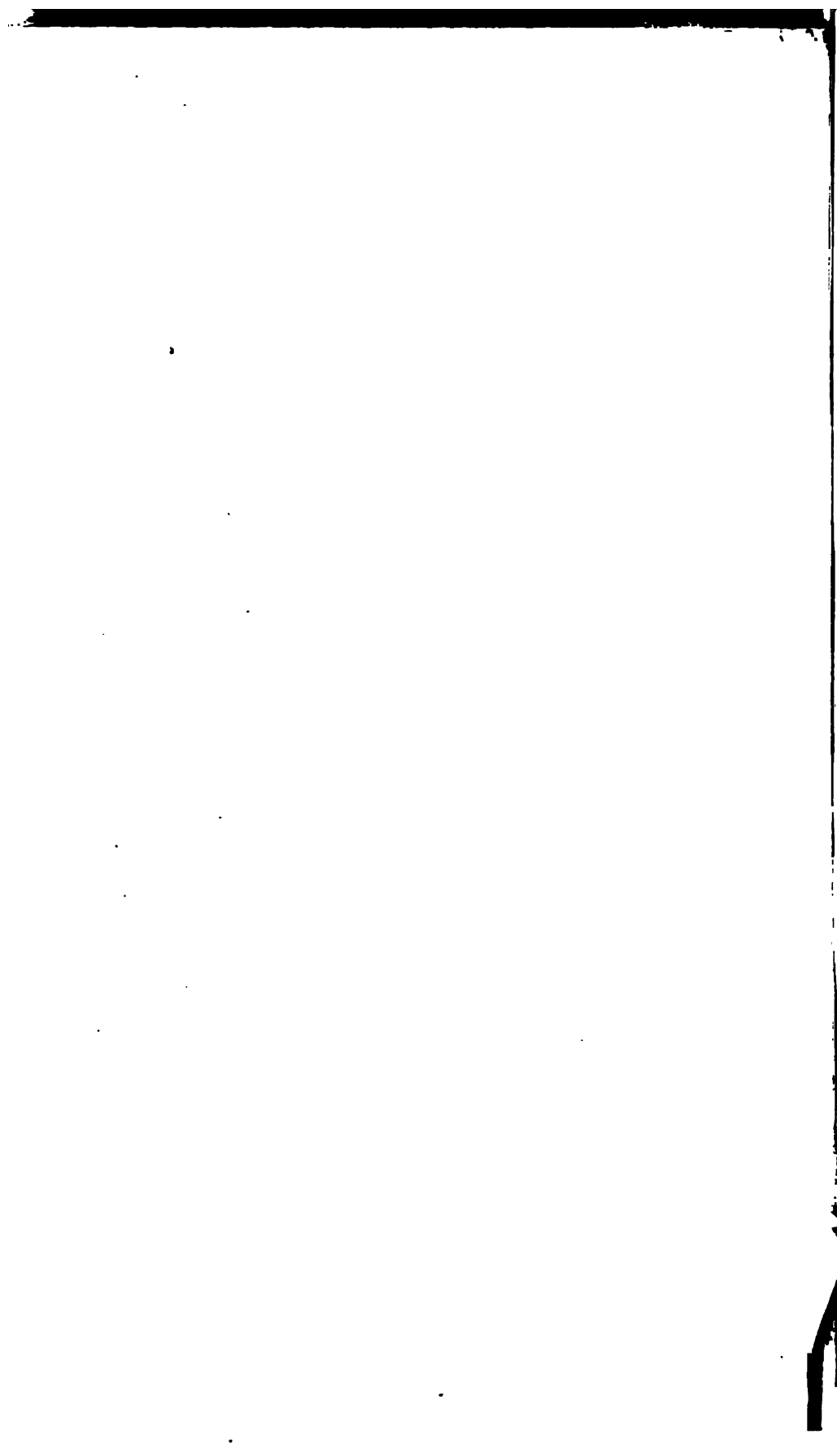
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Queensland.

DEPARTMENT OF MINES.

Geological Survey of Queensland.

(B. DUNSTAN, F.G.S., ASSISTANT GOVERNMENT GEOLOGIST.)

PUBLICATION NO. 205.

SECOND REPORT
OAKS VIEW GOLD MINES
(NEAR ROCKHAMPTON).

WITH THREE PLANS AND TWO PLATES.

AND

NOTES ON THE MINES
TALGAI AND THANE'S CREEK GOLDFIELDS.

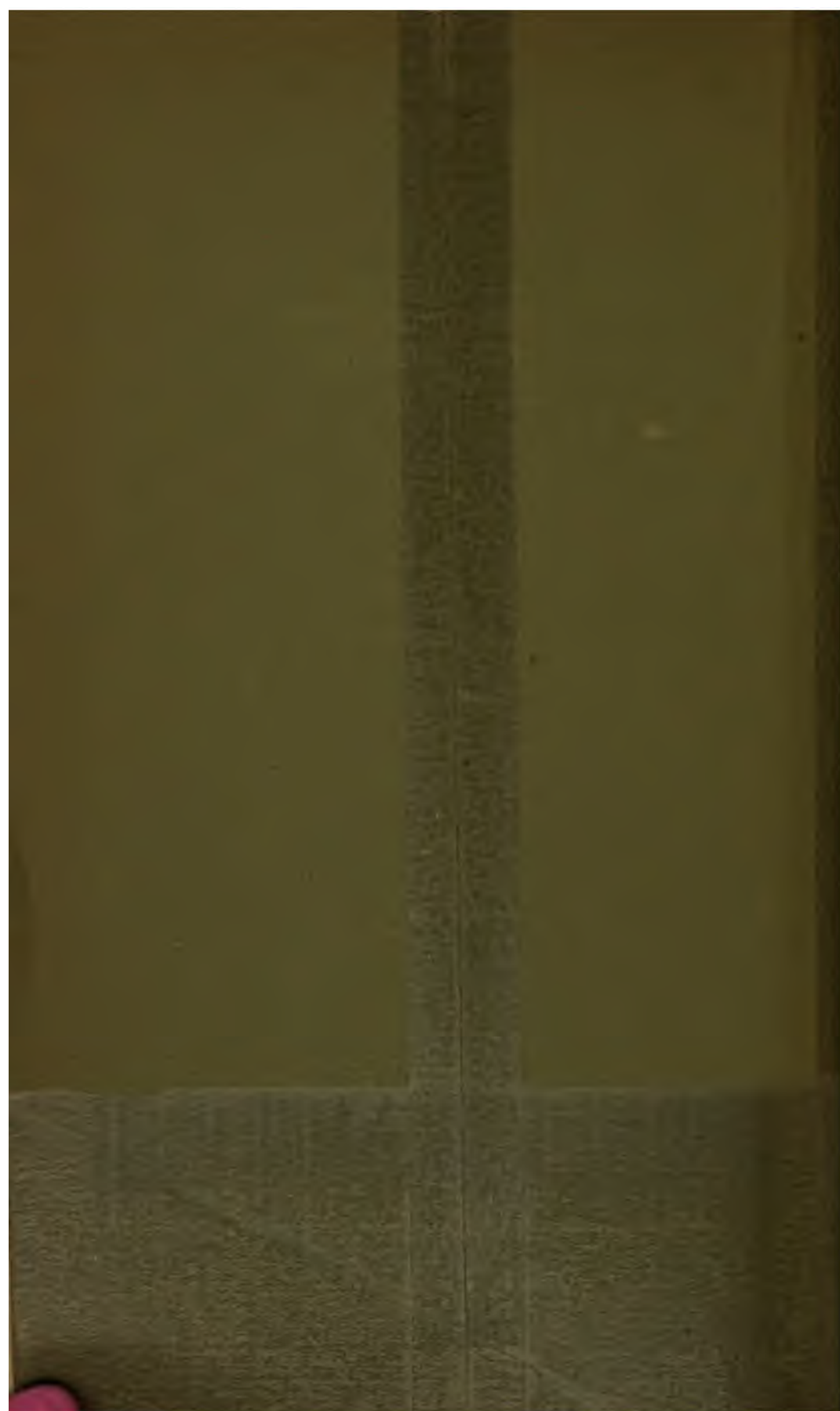
By LIONEL C. BALL, B.E.,
ASSISTANT GOVERNMENT GEOLOGIST.



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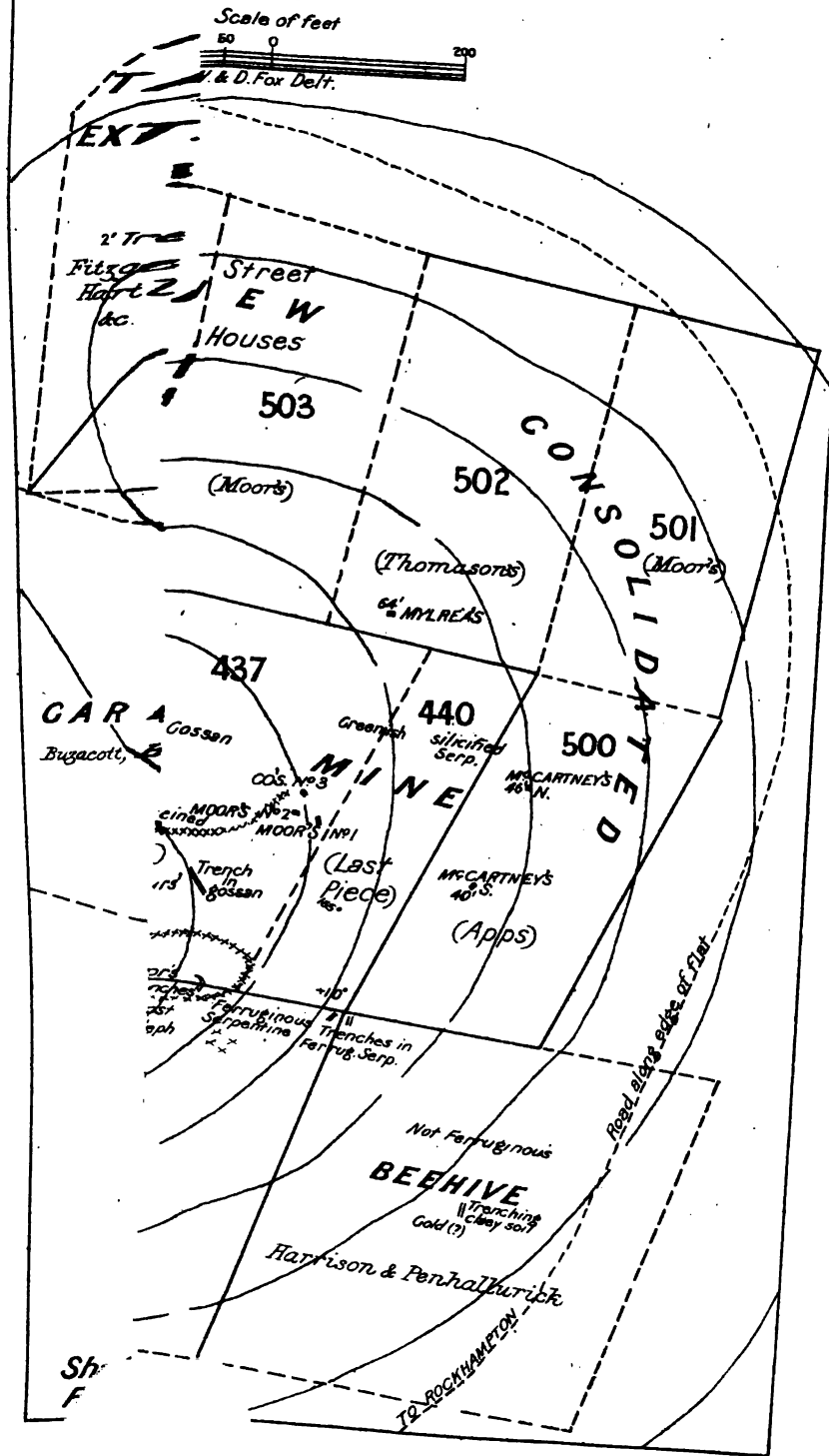
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onel C. Ball B.E.

ant Govt Geologist

1905

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THE OAKS VIEW GOLD MINES.

I. INTRODUCTION.

Oaks View Hill, on which the claims are located, is on Grazing Farm No. 17, Canoona, which is distant from Rockhampton 45 miles by road. Further particulars as to locality, topography, history, &c., will be found in a previous report.*

The population of the field at the beginning of September, 1905, was estimated to be eighty men, women, and children.

The Oaks View Hill, being outside of any goldfield, the ground can only be taken up and held as ordinary claims, under the regulations of the Mining Act, by possessors of miners' rights. Amalgamation of these ordinary claims (200 feet by 400 feet) has now been carried out. The resultant extended claims are ten in number, and cover an area 1,800 feet from north to south and 2,800 feet from east to west.

There has been considerable agitation to have the workings included in an extension of the Canoona Goldfield, which would allow of leases being taken up under a more satisfactory tenure. The employment of two-thirds of the number of men (twenty-four) now compulsory would then fulfil the labour conditions.

II. OAKS VIEW GOLD MINE (No. 441).

(The Oaks View Gold Mining Company, Limited).

1. AREA.

This extended claim comprises:—

- (a) No. 423, the combined reward claim and attached ordinary claim (700 feet by 400 feet), on the former of which are the main or western workings.
- (b) No. 438, the "Crown of the Hill" (300 feet by 400 feet), on which there are no workings.
- (c) No. 437, the "Eva" (300 feet by 400 feet), on which are the eastern workings.
- (d) No. 440, the "Last Piece" (100 feet by 400 feet), on which there are no workings.

These extend from west to east along the brow of the Oaks View Hill, on the northern side.

* Recent discovery of gold at Oaks View, near Rockhampton, by L.C.B., Brish. By Auth. 1906, p. 11, 2 plates. (G.S.Q.P. No. 199). Also Q'land Gov. Min. Jour., vol. vi. (1906), p. 67.

2. WESTERN GROUND (No. 423).

The term western ground is generally employed locally in referring to the reward claim, there being no workings on the remainder of claim No. 423.

I. WORKINGS.

The main workings are on the north-western slope of the hill, just below the brow. They comprise three shafts, Nos. 1, 2, and 2A, with attached stopes, drives, crosscuts, &c., covering an area 240 feet long and up to 70 feet wide. (*See Plan 1.*)

Surfacing.—The surface soil to a depth of two feet has been removed (for crushing) over a distance of a chain west and north of No. 1 shaft. About $2\frac{1}{2}$ chains north-west of No. 1 shaft a trench twelve feet long was sunk to a depth of 17 feet.

No. 1 Shaft (5 feet 6 inches by 3 feet) has been sunk vertically to a depth of 74 feet, the brace being five feet below that of No. 2 shaft. It was, when last seen, only 18 feet deep, but has since been deepened in search of a defined footwall. At a depth of 17 feet the shaft is connected with the stopes now extending downwards and eastwards to the No. 2 shaft (and thence north-eastwards to the No. 2A shaft). Besides the stope, which has an average width of about 25 feet, with a length of 70 feet, there are several radiating drives, with a total length of 150 feet, the positions of which can be seen on the accompanying plan (Plan 2). A crosscut runs 19 feet south 25° west from the bottom of the shaft.

No. 2 Shaft is slightly further up the hillside, the brace being 5 feet above that of No. 1, from which it is distant 54 feet east 6° north. It is 44 feet vertical to the stopes, which continue up to No. 1 and down to No. 2A shafts.

From No. 2 shaft a drive runs due north for 30 feet and south for ten feet. Then an inclined stope, gradually narrowing down to a drive, extends east-north-east for 47 feet, and at the bottom is a prospecting drive running 25° to the south-by-east. Two drives, ten feet apart, run ten feet to the west from the bottom of the inclined stope, and are then connected by an underlie 40 feet in length, from the upper end of which a crosscut extends 15 feet to the west-by-north. From the lower end of this underlie a drive, 40 feet in length, connects with No. 2A shaft, and the ore above it has been stoped out for a distance of 30 feet. Beyond the stope the drive extends 30 feet, and from it two crosscuts branch off, one, 35 feet in length, to the south-west, and one, ten feet in length, to the west-by-north. From the same drive west of the No. 2A shaft two inclines, thirteen and 20 feet in length, have been carried down on the ore, and from the bottom of the latter a crosscut has been carried back to the south-west for ten feet.

PLAN 2

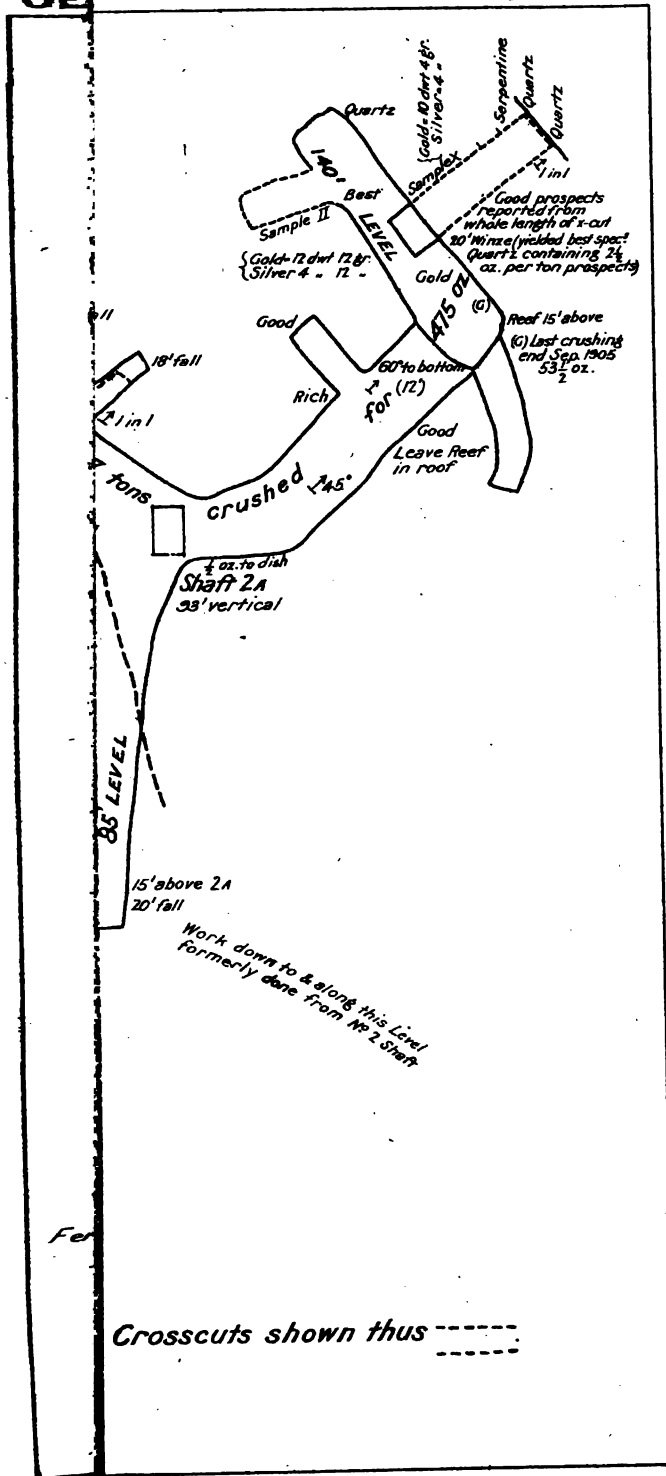




Photo., L. C. Bull.

WHIP SHAFT, WESTERN WORKINGS, OAKS VIEW G.M. CO.

No. 2a Shaft lies 87 feet north 40° east of the No. 2 shaft. It is 89 feet deep, the brace being 18 feet below that of the No. 2 shaft. (See Plate 1.)

From the shaft a wide inclined drive runs easterly for ten feet, and then north-easterly for 30 feet, to a level opened 25 feet to the north-west and 18 feet to the south. At the western end of the level is a ten-foot crosscut to the south, while from the centre of the level a winze has been sunk 20 feet, and a drive carried 20 feet to the north-east.

II. ORE BODIES.

The western workings have proved a shoot of payably auriferous ore to extend from the No. 1 shaft nearly eastwards to the No. 2 shaft, with an average width of 25 feet. Beyond the No. 2 shaft the run has trended more to the north-east. In the No. 2A workings the rich shoot appears to have a width of 30 feet or more. The greatest width proved by stope and drive in the No. 1 workings is 50 feet; in the No. 2 workings 45 feet; and in the No. 2A workings 70 feet; while on the bottom level 40 feet has been exposed.

The method hitherto adopted having been to follow the richest gold, little is known as to the extent of the "pay ore." The thickness may be gauged by the height of the stopes—four to six feet (and even ten feet); and it may be taken to average five feet six inches, varying as it does between four feet in the upper and ten feet in the lower workings.

The No. 1 shaft sinking comprised:—

Gossan, from the surface to 45 ft. depth	Occasional colours of gold.
Serpentine (9 ft.) to 54 ft. depth	...	...
Gossan (10 ft.) to 64 ft. depth	...	...
Kaolinised ferruginous serpentine (10 ft.) to 74 ft. depth	...	...

The drive passed from serpentine to gossan within ten feet, and, after three feet, into ferruginous and cherty quartzose ore. This is very promising in appearance, being identical with ground proved rich in the No. 2A workings; but a sample taken by me was crushed and washed for only traces of gold. The dip of the whole is from 45° to 60° to the north-east, so that the belt of serpentine in which sinking ceased should be at least 20 feet thick.

The deeper workings are important, as they prove the gossan and intercalated layers of serpentine to have a thickness of at least 60 feet; and, though poor in the drive, very little additional exploring might reveal rich ore.

The floor of the No. 1 stope is formed by a lenticular layer of serpentine, which cuts out to the north-east of the No. 1 shaft. It is, therefore, within the bounds of possibility that "pay ore" may be found beneath that serpentine.

At 15 feet from the surface in No. 2 shaft, a four-foot quartz reef was cut through, while beneath it was auriferous gossan, which was not properly tested because the shaft was being sunk to the bottom of the

No. 1 stope for ventilation. It is now believed that this gossan is the same as that being worked below No. 2A shaft, and that two distinct gold-bearing layers have been worked—that in the No. 2A workings being an upper, and that in the No. 1 workings a lower. The present workings connecting No. 2 and No. 2A shafts are in country separating the two auriferous zones.

In the No. 2A shaft the lode material was cut, beneath a six-foot quartz reef, at 83 feet from the surface, and was sunk in for six feet. The quartz reef is being left standing, as it forms a splendid roof. It is presumed to be that cut in the No. 2 shaft at 15 feet depth.

The evidence of the workings shows the trend of the ore body to be not towards the eastern workings, but towards the Magazine Rock on the south-east. The network of quartz veins in the serpentine there may be taken to represent the solid quartz vein found in No. 2 and No. 2A workings. It has, however, yet to be proved that the gold persists as well as the gossan and quartz. Some prospecting was done in the vicinity of the Magazine Rock twenty years ago; but, though the ore appears promising enough, the gold is absent, or present only in small quantities. Similarly the work towards the north-west has been discouraging. The stone from the deep trench to the north-west of the No. 1 shaft was crushed for an average yield of 3 dwt. per ton—that on the surface carrying 6 gr. to the dish ($1\frac{1}{2}$ oz. per ton), while that beneath decreased in value rapidly. This would indicate that the ore body should be expected rather to the west than the north-west of the workings.

Gossan does occur at intervals between the western and eastern workings, and gold has been found in the soil along the whole of the northern side of the Oaks View Hill; consequently there seems to be more likelihood of gold being found in an east and west belt than along the true strike to the north-west and south-east, but nothing has been done to prove the existence of ore deposits.

III. ORE.

The ore is, in main part, a gossan, consisting as it does of a siliceous framework filled in with ferruginous clay. Patches of unaltered serpentine and flecks of a green chrome-bearing silicate are distributed irregularly through it, and crystalline quartz of two growths can be washed out of the ore from the bottom level. The most promising stone is cellular gossan (palpably leached serpentine), containing streaks of dark-coloured magnesian silicate, and veined to a large extent with granular blue quartz, the thin ($\frac{1}{8}$ -inch) lenticular leaders showing no orientation. The bulk of a ton of gossan, as sent to the mill, has been determined by Mr. O'Meara to be 34 cubic feet.

The reef is simply serpentine, veined and almost entirely replaced by quartz; and that the replacement has taken place along a fissure is indicated by the splendid foot-wall (and hanging-wall also) with attached polished fluean.

The distribution of the gold in the gossan is very irregular, rich patches being frequently separated by seemingly identical but almost barren ore. The gold cannot be seen in the faces, and its presence or absence has to be proved by sampling and panning off.

The gold from the bottom crosscut (160-foot level) is both fine and granular, the latter being coated by blue-black manganese dioxide or magnesian silicate. The manganese dioxide has often a light blue tinge, and is commonly known at the Oaks View as cobalt. My specimens being packed away, I have not yet been able to test them for cobalt.

IV. SAMPLES.

The following samples were not taken with any idea of valuing the mine, but to test the payable thickness in the lower workings, for it was understood that the whole of the workings, including the crosscuts, were in payable ore. To determine the value of the present faces samples would have to be taken throughout the workings, from roof to floor, at not more than ten feet apart, and this would necessitate the taking of at least 100 samples. It is not certain that a reliable estimate could even by that means be secured, for the richer ore has been broken down and raised, leaving poorer faces, though the ore a few feet inside might be still richer. The occurrence of the gold in patches or bunches adds another difficulty.

Sample 1: From the bottom of the lowest winze (160-foot level) in the No. 2A workings and for six feet along the crosscut; assayed by the Government Analyst:—

Gold, 10 dwt. 4 gr. per ton.
Silver, 4 dwt. „

Sample 2: From the whole length (about ten feet) of the southern crosscut on the 140-foot level in the No. 2A workings; assayed by the Government Analyst:—

Gold, 12 dwt. 12 gr. per ton.
Silver, 4 dwt. 12 gr. „

Sample 3: From the southern crosscut (35 feet in length) on the 70-foot level; assayed by the Government Analyst:—

Gold, nil.
Silver, trace.

Both samples 1 and 2, it will be seen on reference to the plan attached, were taken from ore over five feet from the quartz reef, that immediately along the reef having been proved (on the 140-foot level) to be still richer. They, therefore, prove a considerable thickness of ore over a limited area to be still payable in the deepest workings. I saw samples from the bottom crosscut washed for 6 gr. to the dish ($1\frac{1}{2}$ oz. per ton) without crushing, and Mr. Apps, the sampler, informed me he got good prospects from the whole length of the crosscut.

With regard to sample 3, the whole length of the crosscut was included, as it differs very little in appearance from gossan proved

rich elsewhere, and as I was not informed of the fact that fair prospects were obtained only from the manganese-stained gossan within a few feet of the inner end.

V. OUTPUT.

From the surface:—

345 tons yielded ... 85 oz. = 5 dwt. per ton.

Surface to 44-foot level:—

1 ton 12 cwt. dish tailings yielded 19 oz. = 11 oz. 17 dwt. per ton.
160 tons yielded ... 305 oz. 4 dwt. = 1 oz. 18 dwt. per ton.

February to December, 1904:—

Prospects washed in dish ... 327 oz. 4 dwt.
Making a total of ... 651 oz. 8 dwt. = 4 oz. per ton.

44-foot level to 101-foot level:—

318 tons yielded ... 342 oz. = 1 oz. 1 dwt. per ton

101-foot level to 146-foot level:—

387 tons yielded ... 475 oz. 11 dwt. = 1 oz. 4 dwt. per ton.

Total to the end of September, 1905:—

1,211 tons 12 cwt. yielded 1,228 oz. 15 dwt. = 1 oz. per ton.

The above returns were given me by the manager (Mr. O'Meara). The monthly returns from the secretary (Mr. Catt), which include both eastern and western crushings, are:—

1905, Jan.:	119 tons for	227 oz. 6 dwt. = 1 oz. 18 dwt. per ton.
March:	380 „	130 oz. 14 dwt. = 6 dwt. 20 gr. „
April:	86 „	62 oz. 18 dwt. = 14 dwt. 15 gr. „
May:	96 „	34 oz. 0 dwt. = 7 dwt. 2 gr. „
June:	122 „	267 oz. 0 dwt. = 2 oz. 4 dwt. „
July:	96 „	202 oz. 10 dwt. = 2 oz. 2 dwt. „
Aug.:	142 „	128 oz. 0 dwt. = 18 dwt. „
Sept.:	149 „	144 oz. 17 dwt. = 19 dwt. 11 gr. „
	1,190 „	1,197 oz. 5 dwt. = 1 oz. „

The value of the gold washed out by the prospecting syndicate was £3 10s. per oz., while that of the ingots sent from the mine varies between £3 10s. and £3 15s., the average being £3 14s. per oz.

3. EASTERN GROUND (No. 437).

The eastern ground comprises claims Nos. 437 (the "Eva") and 440 (the "Last Piece"), on the the latter of which no work has been done.

I. WORKINGS.

Work was begun by Moor on the "Eva," but some work has lately been done by the company, the location being almost 1,100 feet east of the western workings. (See Plan 3.)

Moor's No. 1 shaft is 18 feet deep (vertical), and underlies 1 in 1 for 15 feet.

Moor's No. 2 shaft, 25 feet to the west of No. 1, is really only a few feet deep, but connects with No. 1 at the 17-foot level by an irregular stope.



The Company's No. 3 shaft, 30 feet north-west of Moor's No. 1, is vertical to 47 feet depth, at which point a level runs 16 feet westwards and 18 feet eastwards to a small stope connected with Moor's No. 1 and No. 2 shafts. The shaft continues northwards on the underlie (at an angle of 60°) for 24 feet to a second level extending five feet westwards and 25 feet eastwards. From this level, at 17 feet from the underlie shaft, an underlie winze descends 48 feet, there being levels five feet west and 22 feet east and south-east at 14 feet below the 72-foot level.

Much of the stone hitherto crushed has come from the stope between the 47-foot and 72-foot levels.

II. ORE BODY.

The eastern workings are located upon a single shoot, which pitches towards the north-east. The width of the shoot was 24 feet on the 47-foot level and 30 feet on the 72-foot level, but on the 87-foot level only 15 feet has yet been proved. The thickness of ore broken down between the 47 and 72 foot levels was from 20 to 24 inches.

In the Company's No. 3 shaft the sinking from 12 to 20 feet was through cherty country, beneath which is four inches very rich, soft, clayey, gossany slate and ironstone, dipping north-easterly; gossany material underlies this to the shaft bottom.

On the 47-foot level, however, no fault can be seen between the ore body and the solid black serpentine footwall, and none between the ore and the crushed serpentine on the hanging-wall, but a well-defined fault plane separates the crushed serpentine from the overlying rock.

The lower workings are undoubtedly on a line of faulting, the foot and hanging walls both having considerable slickensides and flucan.

On the 87-foot level some confusion has been occasioned by an oblique fault from the south-east, which has been followed instead of the main fault, the gold having in consequence been lost. This fault shows strong vertical slickensides.

Both hanging-walls and footwalls in the lower levels are crushed (slickensided) serpentine.

A black manganese-stained siliceous skeleton, forming a vein from two to eight inches thick, and at any distance within six feet of the fault, but generally forming a footwall for the auriferous ground, is looked upon as an "indicator" here.

III. ORE.

The ore is similar in appearance to that at the western end, the original serpentine having been, however, not quite as thoroughly leached and altered.

Much of the gold here occurs painted on the "faces" of fissures in the serpentine and ferruginous slate. Rich gold has also been found in the flucan of the hanging-wall on the 81-foot level; and on the 47-foot level six feet of crushed soapy serpentine, having to be removed, was milled for a return of 6 dwt. per ton.

IV. OUTPUT.

22 feet to 84 feet :—

53 tons for 61 oz. 10 dwt. = 1 oz. 4 dwt. per ton.

Lowest portion of stope and 24-foot level :—

October, 1906—23 tons for 45 oz. 10 dwt. = 2 oz. 1 dwt. per ton.

47-foot level :—

16 tons for 26 oz. = 1 oz. 12½ dwt. per ton.

30 tons for 9 oz. = 6 dwt. per ton.

4. EXPLOITATION.

The ore has hitherto been got with little or no system. A shaft was first sunk in the outcrop of the western ore body. Samples were then taken from the face and panned off without a preliminary crushing, a drive (sometimes opening out into a stope) being then opened on the side where the richest prospect was found. Each day the faces were prospected by sampling (three dozen places sometimes), and the direction of the work altered accordingly, so that even now some parts of the workings have much resemblance to a rabbit warren. When ventilation became impaired and haulage began to become difficult, a second shaft was sunk to the lowest end of the first workings, and work was then continued to the dip. Thus, shafts Nos. 2 and 2A have been put down, and it seems likely that another will soon be required. Drives and inclines (located on richer strings of gold) branch out from the stopes in all directions, and six crosscuts have been carried back into the poorer gossan in search of a footwall.

Three shifts are now at work in the bottom crosscut, each containing two men picking down the ore, one man filling the greenhide buckets at the shaft, and two men on the brace hauling. There is a sampler on the day shift, and when work is going on fully four additional men are employed in the mine.

As mentioned elsewhere, the samples taken daily in the mine are washed without a preliminary crushing, it having been found (by crushing check samples) that, if the prospect is poor from an uncrushed sample, the crushed ore will give a result very little better. Most of the gold must, therefore, occur in the soft earthy portion of the ore, and not in the quartz veinlets.

Just previous to my visit exemption had been secured, because of the want of water, but an opportune storm had replenished the dam, and crushing had been resumed, though only partial work was going on in the western ground, and none in the eastern.

5. TREATMENT.

I. TRANSPORT.

The ore is raised in greenhide buckets by windlass, and is carted from the shafts down the hill to the boundary of the machine area, where it is tipped on the ground. It has then to be loaded on a small trolley running on rails to the automatic feeders. It is thus evident

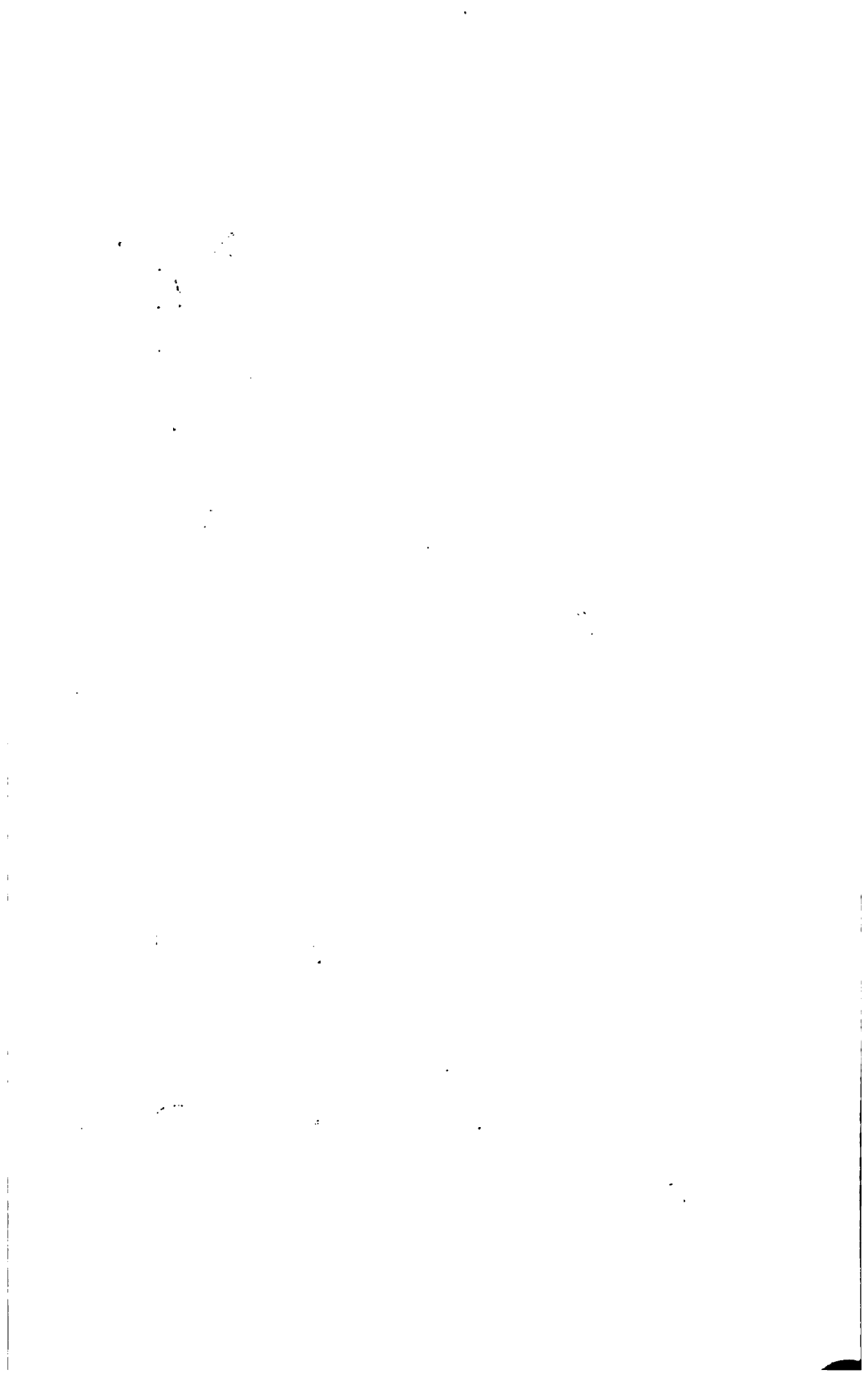




Photo., L. C. Ball.

CRUSHING MILL, OAKS VIEW G.M. CO.

Plate 2.

that there is abundant room for improvement. The construction of a double tramway to the western workings will, of course, be undertaken sooner or later, and the erection of storage bins at the mill is a matter of prime importance in the reduction of costs.

II. MILLWORK.

The mill consists of one five-foot Huntington mill (with five discharge openings with screens having thirty meshes to the linear inch) in operation, and one (with three openings) in course of erection. The mill is provided with "Challenge" automatic feeder, and is now putting through about ten tons a day (this being one-half its capacity, running at 52 revolutions per minute), but the rate is varied according to the richness of the ore. Copper-plate tables are provided for the mills, but it is found that 85 per cent. of the gold is amalgamated in the mill itself, owing to the extended trituration. It is believed the gold is slightly coated.

The mills are found to give perfect satisfaction with the gossany ore, but with the quartz the millers are worn too rapidly.

A partial clean-up is made once a week, the amalgam being then removed from the well and fresh quicksilver added.

The average contents of the tailings, now amounting, approximately, to 1,500 tons, is 1 dwt. 4 gr. per ton. The slimes were expected to be slightly richer, and were, therefore, saved, but a 200-ton trial by cyaniding proved them to carry only from 1 dwt. 4 gr. to 1 dwt. 8 gr. per ton.

The mills are driven by a 20-h.p. (44 I.H.P.) semi-portable boiler and engine (two 10-inch cylinders with 14½-inch stroke), capable of running three 5-foot mills.

The cyanide plant consists of two galvanised-iron tanks 15 feet in diameter and three feet six inches high, and one ten feet in diameter and five feet high (sump).

The men employed at the mill (for three shifts) comprise three drivers, three feeders, a woodcutter, and the manager.

The question of a water supply has occasioned some trouble here. That first obtained from shallow wells proved very limited in quantity, being derived entirely from sub-soil drainage; and, in consequence, a dam had to be excavated. This has an average diameter of 2½ chains, and an average depth of four feet, its capacity being 900,000 gallons when full, that being sufficient to keep the mill going for four or five months.

The water is pumped from the dam by a Worthington duplex pump, and is returned to the dam again from the settling pits. A Tangye pump, with Tonk patent valve, is installed in the well.

In order to supplement the dam supply, a six feet by six feet well was sunk adjacent to the mill to a depth of 24 feet, and a drive,

intended to be 100 feet in length, has been opened out 18 feet under the flat on the north. The quantity being raised (6,000 gallons per 24 hours) about equals the loss from evaporation in the dam.

III. OAKS VIEW CONSOLIDATED (No. 517).

1. AREA.

The Oaks View Consolidated (claim No. 517) adjoins the Oaks View on the north and east, and comprises claims Nos. 508 (originally Nichol's), 507 (originally Cohen's), 506, 505, 503, 502 (originally Homeward's and Mylrea's), 501, and 500 (originally McCartney's). It is now held by the Oaks View Gold Mining Company, but all the work on it was done by the former holders.

Workings are to be seen on Nos. 508, 507, 502, and 500; but none of the shafts could be descended. On Nos. 506, 505, 503, and 501 practically no work has been done, even in prospecting the surface.

2. NICHOL'S (No. 508).

Workings.—Nichol's shaft (41 feet below No. 2) is situated 260 feet north-north-east of the No. 1 shaft on the reward claim.

It is now inaccessible (having been abandoned because of water trouble), but is reported to be 118 feet deep. Water-level is at 102 feet beneath the surface. The Company has done nothing on this ground, but the manager intends to put men on to prove it as soon as circumstances will permit.*

Ore Body.—It is understood that this shaft passed through a quartz reef into an ore body similar to that in the western workings (on the reward claim). The ore on the surface, said to have come from 118 feet depth, is identical in appearance with that in those workings, and good prospects of fine gold can be washed from it. The ore bodies of the reward claim should not, however, be struck here at much less depth than 200 feet from the surface, unless a very considerable flattening takes place.

3. COHEN'S (No. 507).

Workings.—Cohen's shaft, 45 feet below No. 2, lies 360 feet east-south-east of Nichol's. The reported depth is 130 feet. The shaft is inaccessible, work having been stopped because water was struck.

Ore Body.—The sinking seems to have been in light brown and sometimes greenish altered serpentine. The last few bucketsful raised consist of leached, quartz veined, and banded black gossan, which carries very good prospects of flour gold. Flour gold (which is considered a good sign) was reported at a depth of 120 feet, and "colours" between 100 and 130 feet. It is to be hoped that further prospecting work will be undertaken here, both in the ore found and in further sinking the shaft.

* December, 1905: Mr. O'Meara informs me he is driving S.W. at 100 feet depth.

4. MYLREA'S (No. 502).

Workings.—Mylrea's shaft is 210 feet north-north-east of the company's No. 3 shaft (at the eastern end). It is 64 feet deep.

Ore Body.—Though gossany, quartz veined, and replaced serpentine has been raised, from below ferruginous serpentine in the sinking "pay ore" has not been reported.

5. McCARTNEY'S (No. 500).

Workings.—The northern shaft lies 230 feet east by north of the company's No. 3 shaft. It is 46 feet deep.

The southern shaft, 110 feet to the south-south-west, is 46 feet deep.

Ore Bodies.—The northern shaft was sunk to a blue quartzite (replaced serpentine) in the gossan, above which gold has been found. Chalcedony, zoned and faulted, and also magnesite, are to be found on the tip from this shaft.

The southern shaft is understood to have been sunk on the division between auriferous stone (fair prospects), and serpentine for 18 feet at least above bottom. The serpentine at bottom dips north-eastwards.

IV. FEDERATION AMALGAMATED (No. 490).

The claim is irregular in shape, being 400 feet wide and 500 feet long. It includes the ground formerly held by Hyde and Clark and Hinze and Pacey, and adjoins the reward claim on the west. The claim, being under exemption, was unmanned when inspected, and of the shafts only Hinze's and Pacey's could be descended.

1. HYDE'S AND CLARK'S.

The shaft (about 25 feet below No. 2 of the Company), in the north-eastern corner of the claim, was abandoned at 105 feet, because of water inflowing.

At 20 feet (?) depth, 20 feet of quartz and quartz-veined country (which outcrops about 50 feet up the hillside) was struck. The quartz is cherty, with bluish manganese stains, and contains green silicates. Prospects of gold were found, so it was paddocked, but a surface sample of the quartz in the paddock (believed to carry 7 dwt. per ton) yielded (Government Analyst):—

Gold, Nil; Silver, Trace

The gossan was not sampled, though reported to be auriferous.

2. EVANS.

The shaft is near the centre of the reward claim boundary, and was, in fact, sunk by the prospectors. It is twelve feet deep.

A sample was taken from the gossan thrown out of the shaft and panned off for a trace of gold.

3. CLARK'S.

The shaft lies about a chain west of Eva's. It is only a few feet deep.

A sample of the gossan on the brace was panned off, but yielded no gold.

4. HINZE'S AND PAGEY'S.

The shaft (about 25 feet below the company's No. 2) is located in about the centre of claim No. 490.

It is vertical for ten feet from the surface, and then underlies at 75° (to the north 25° east) for 40 feet. Levels have been commenced at 20 feet, 30 feet, and 45 feet from the surface (15 feet, 25 feet, and twelve feet in length). The proposal for the future is to sink a shaft 50 feet to the north of the present one, to cut the reef at a slightly greater depth than the underlie workings.

A couple of feet of gossan forms the hanging-wall; this is altered serpentine, and is very promising in appearance, but it contains only odd colours of gold. Beyond this is two feet of slickensided rotten serpentine, with laminated green chrome (?) silicate, and then gossan again. The footwall is also formed by gossan.

The reef is very bulgy, varying from six inches (or less) to six feet in thickness, while the average is two feet. There is no sign of fissure, except occasionally centrally in the vein. The footwall is unusual, in that it breaks from six inches to a foot into the reef every few feet as the descent is made, while the hanging-wall remains unbroken.

The quartz is sometimes similar to that in the No. 2A workings, in being cellular. It contains solid limonite and bunches of green chrome (?) silicate. The best gold is found where the reef is thin. A test was made in the Oaks View United mill of—

13 tons, which yielded $\frac{1}{2}$ oz. per ton.

and 40 tons of similar stone now lies at grass, as $\frac{1}{2}$ -oz. stone would not pay to work on a small scale.

V. O'MEARA'S (No. 513).

The claim is 200 feet by 400 feet in area, and adjoins the reward claim on the north, and the Consolidated on the west.

The only work (the sinking of about a dozen shallow shafts (4 feet 6 inches by 2 feet) hitherto done has been in search of alluvial, in a small gully running northwards from the western workings.

Near the reward claim the gold is found at a depth of from three feet to eight feet, but on the flat nearer the battery it is being found at 16 feet beneath the surface. No defined run has been found, but the whole of the gold is believed to be within the confines of the claim, the lowest shaft being a duffer. The gold is fairly coarse ($\frac{1}{4}$ -inch diameter), is only slightly rounded, and has evidently been shed from the western ore body. Only $1\frac{1}{2}$ oz. had been saved at the end of October, 1905.

VI. TARCOOLA (No. 518).

Claim No. 518 is 400 feet by 400 feet in area. It adjoins the north-western corner of the reward claim.

The only work done on this claim has been the sinking of three holes to six feet depth. In one of them there is said to be a leader, but only slate and quartzite are now exposed, though occasional fragments of gossan (said to be auriferous) are found in the soil. The ground is probably held for the purpose of proving at a depth any deposit that may be brought to light on the adjoining Federation Amalgamated.

VII. TARCOOLA EXTENDED (No. 519).

This claim has the shape of a rhomb, with sides 400 feet in length. It adjoins the Tarcoola and Federation Amalgamated on the west.

In the eastern corner a two-foot trench has been opened across a quartz outcrop, the total width of which is 17 feet 6 inches. The quartz, much of which is slightly chalcedonic, is evidently replaced serpentine, and differs from that in the western workings on the reward claim, which is only partly replaced. A sample was taken from the whole length of the trench, but yields (Government Analyst):—

Gold, Nil; Silver, Trace.

The hanging-wall side of the reef is beautifully polished, proving it to be on a line of movement of some extent. Its dip is 42° to the north 50° east. It is thus probably the same reef as worked in Hinze's and Pacey's shaft on the Federation Amalgamated. Adjoining the reef on the north-east is 2 feet 6 inches of rotten, green, silicate-bearing serpentine, under a six-inch leader. This seems more likely to prove auriferous than the reef itself, and prospecting (with the dish) of the surface soil along both sides of the quartz reef is therefore advised.

VIII. GARDEN.

This claim, 400 feet by 800 feet in area, is the last pegged out. It lies south of the Federation Amalgamated, and west of Penhallurick's Extended Gold Mine No. 4.

No work has yet been done here.

IX. PENHALLURICK'S EXTENDED GOLD MINE, No. 4.

The claim is 400 feet by 200 feet, and is situated at the south-western end of the reward claim.

No work has yet been done here.

X. BEEHIVE.

The area of this claim is 400 feet by 400 feet. Its location is adjacent to the south-eastern corner of the Oaks View, and south of the Consolidated.

There is a trench in ferruginous serpentine in the north-western corner, and a trench was being made in the centre of the claim when I left the field, but it had not then passed through the soil.

XI. OAKS VIEW SOUTH EXTENDED UNITED GOLD MINE (No. 514).

The claim is generally known as Penhallurick's. It has an area of 800 feet by 400 feet, and adjoins the Oaks View Gold Mine on the south. Only southern slopes of the Oaks View Hill are included within its limits.

The only prospecting work done on this claim has been the opening of a few trenches near the hilltop, just within the northern boundary. The gossany and quartz-veined outcrops here are promising enough, but I am not aware of any gold having yet been found.

The original prospectors of the "Crest of the Hill" sank a shaft to a depth of 20 feet on the hilltop, in what is now the north-eastern corner of this claim. They found only light, rotten serpentine.

The present holders are now opening an adit half-way down the hillside, in the eastern part of their ground in the hope of striking, within 300 feet, the extension of the ore body of the reward claim.

XII. TINKER'S HILL.

Tinker's Hill, a mile north of the Oaks View Hill, received attention from a party of prospectors, and was, therefore, inspected. It consists chiefly of schist and quartzite, and the only trench opened is in an outcrop of the latter rock. Colours were once reported, but no gold can now be found, and the claim is expected to be abandoned.

Black's Hill lies $\frac{3}{4}$ -mile east-north-east of Tinker's Hill. It is composed of ferruginous shale and quartzite. Colours of gold were said to have been found on it, but no confirmation can be had of the rumour.

30th November, 1905.

NOTES ON THE MINES
TALGAI AND THANE'S CREEK GOLDFIELDS.

By LIONEL C. BALL, B.E.,

ASSISTANT GOVERNMENT GEOLOGIST.

THE UNIVERSITY OF CHICAGO

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NOTES ON THE MINES

TALGAI AND THANE'S CREEK GOLDFIELDS.

INTRODUCTION.

The following notes were prepared while on a brief visit to the fields in August, 1905:—

On the return journey a correction was made in the delimitation of the granite area on the Warwick-Goondiwindi Railway, such area being observed to extend between the 17½-mile peg (two miles beyond Cunningham) and the 22¾-mile peg (one mile before reaching Thane). The granite is a typical coarse biotite variety, apparently occupying the floor of the wide, flat, fertile valley stretching some six miles south of the railway. The glimpses of the cuttings obtainable from the

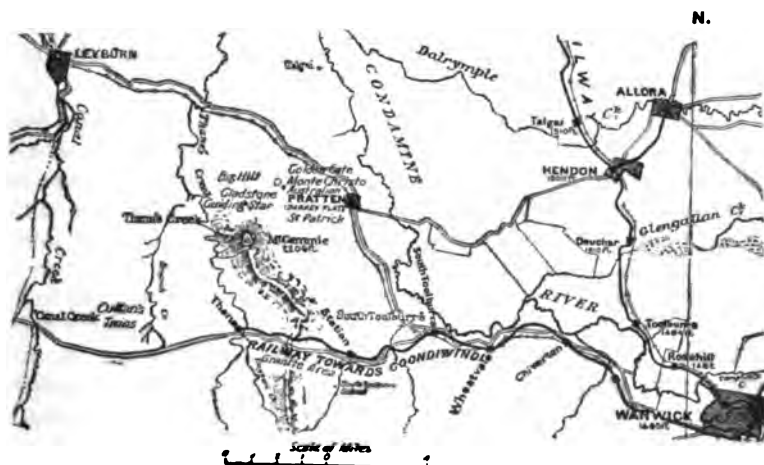


FIG. 1.—LOCAL SKETCH, SHOWING POSITION OF CULLAN'S TWINS, ETC.

moving train point to the granite being intrusive in the slates and quartzites of the Thane's Creek and Talgai Goldfields. To this intrusion may naturally be ascribed the occurrence of the reefs in the slates, which may, therefore, become more permanently defined as the granite is approached.

MONTE CHRISTO, Etc.

The Monte Christo lease adjoins the Big Hill lease on the south, and lies about three miles west of Pratten, the commercial centre of the Talgai Goldfield.* The present holders bought the property from the liquidators of the Pratten Gold Mining Company.

Within its boundaries three lines of reef have been worked, and there are still other outcrops.

1. MONTE CHRISTO.

An application was made in July, 1905, for Government assistance to the extent of £300 to continue the new vertical shaft from 174 feet to 270 feet, at £4 per foot, and to crosscut north and south. In my report on that application I advised that prospecting should first be done on the reef where exposed in the old workings.

New Workings.—The new vertical shaft (begun in 1903 because the old workings were then inaccessible and believed to be unsafe) is 6 feet by 3 feet, part timbered, of two compartments, and provided with windlass and whip. It lies $2\frac{1}{2}$ chains distant to the south 20 degrees west from the fifth shaft from the eastern end of the Monte Christo workings. In it the only change (from grey, sandy, slate grit) is at 25 feet from the bottom, where there is a one-foot band of white kaolinised rock, dipping 40 degrees to the south-east. This indicates the proximity of the Monte Christo reef and leaders. Taking everything into consideration, my calculations indicate that the reef should be struck at about 18 feet below the shaft bottom—i.e., at a depth of 192 feet.

Old Workings.—The only shaft now accessible is the third from the eastern end of the workings, and lying north 44 degrees east of the new vertical shaft. It is vertical for 26 feet, at which point the reef was struck, and from which it was followed to the bottom on the underlie for 15 feet at 56 degrees (then stopes lying on both sides), for 15 feet at 35 degrees, for 20 feet at 45 degrees, for 30 feet at 53 degrees (stoped only down ten feet), and for ten feet at 35 degrees to the bottom (several (?) feet filled in), the total vertical and underlie being 117 feet. The angle of dip thus averages about 45 degrees. A drive was carried along the reef to the east from the foot of the underlie for about 50 feet, where, on a local bend, the dip is 63 degrees to south 20 degrees east. About 33 feet from the underlie is a stepped winze 20 feet deep, the bottom of which is connected with the eastern shaft (90 feet from that last descended). From this eastern shaft a crosscut 165 feet in length runs out to the south, in the search for a large but poor reef, to be seen on the surface near the shaft.

At 60 feet vertical depth is a crosscut in the hanging-wall, in which at 30 feet from the underlie a leader dipping 40 degrees to

* See late Discovery of Gold near Pratten, Talgai Goldfield, &c. (G.S.Q.P. No. 186.)

south-west was met. A big chamber has been excavated at the level of the bottom of the main underlie, though it is reported that the leader was generally only a few inches thick. It is probable that branch leaders proved auriferous near the main leader.

Reef.—The Monte Christo reef near the top of the underlie is seen to be only two inches thick, but at the eastern end of the 117-foot level is twelve inches and more, of hungry, glassy quartz. At the foot of the shaft there seems to be a branch running off into the hanging-wall. The reef is 18 inches thick at the eastern underlie, and on the level connecting this shaft with the winze one to three feet of iron-stained quartz is exposed, dipping about 45 degrees. A small sample taken by me gives (Government Analyst)—

Gold	...	...	...	...	...	19 gr. per ton
Silver	...	...	...	...	...	1 dwt. 19 gr. per ton

It is, however, said that the gold was not found in the main reef, but in the stringers bulging off into the hanging-wall, so that the poverty of the above sample must not be taken as altogether condemnatory. In order to test the reef, the whole of the drives and faces should be cleaned up and sampled. Then the underlie should be continued, and drives carried along the reef.

Output.—The total recorded output from the reef is very small. Mr. Rands* gives the yield from 1866 to 1897 as—

244½ tons for 1,222 oz. 3 dwt. — 5 oz. per ton.

The country rock over the greater part of the workings is a white, sandy, kaolinised slate—probably slate altered by thermal solutions—but at the eastern underlie the hanging-wall rock is bluish-mottled slate, very similar to that at 174 feet depth in the new vertical shaft. Further out along the crosscut thin bedded quartzites can be distinctly seen to dip 65 degrees to south-south-east. The reef may, therefore, be on a strike fault.

2. WELCOME STRANGER.

These workings lie 300 feet to north 255 degrees east of the new vertical shaft referred to in the description of the Monte Christo.

Workings.—The two shafts—the prospecting and whip—lie 44 feet apart on a west 10 degrees south line, the former 15 feet deep and the latter 70 feet. The Pratten Gold Mining Company sank the prospecting shaft several feet up the hill—i.e., to the eastward of where the original patch of gold was found on the surface. A well-defined twelve-inch lode was struck at 15 feet depth, and was followed on the underlie to 50 feet depth. At this point the present holders broke down several tons. They then, on the east, sank the vertical whip shaft to 70 feet, and from the bottom opened an inclined stope for 25 feet to the east, reaching five feet below the shaft bottom. In the

* Big Hill Gold Mining Company's Lease, Talgai. By W. H. R. 1898. Bris.: By Auth. (G.S.Q.P. No. 128.)

eastern face of this stope is a crosscourse striking north 15 degrees west, and dipping 85 degrees to west 15 degrees south, and this crosscourse cuts off a large body of barren quartz.

Reef.—In the prospecting shaft the lode is plainly twelve inches wide, but in the whip shaft only two inches of rubbly quartz and limonite was cut. It is, on the whole, vertical, any inclination observable being to the north. The footwall is good, but there is no sharply-marked hanging-wall. The auriferous stone in the company's stope generally followed (lying about six feet above) a floor dipping to the east. The shoot was very flat, its inclination being only about one in four horizontal; and it is therefore probable that the whip shaft has been sunk through it. The lower stopes are therefore below the general run of the gold, for the flat floor referred to crosses the shaft above those stopes. One patch of gold was, however, found in the whip shaft below that floor. Wherever gold was found the enclosing material was clayey, and it was always moist. The metal is also generally associated here with ironstone.

Output.—The output of the Pratten Gold Mining Company is understood to have been $68\frac{1}{2}$ oz., chiefly from two or three pockets in the stope below the prospecting shaft. At 62 feet depth in the whip shaft a patch of 100 oz. of gold was found in a three-inch band of rotten rock, and $3\frac{1}{2}$ tons of stone secured from the vicinity yielded 20 oz. 8 dwt. of gold, valued at £3 19s. 6d. per oz.

The value of the gold won hitherto is about £750, while the mining costs probably did not exceed £200. The property should therefore be worth developing to some extent by sinking and blocking out, instead of opening out large chambers without method, as was done below the whip shaft in the search for bunches.

3. CLARE'S.

This reef passes within three feet of the brace of the new vertical shaft on the Monte Christo lease, and should be cut by a 60-foot crosscut to the south on the 174-feet level, but it has not been sufficiently prospected on the surface to encourage the project of crosscutting.

A shaft on the reef, 17 feet deep, lies 41 feet to the south 75 degrees west of the new vertical. In it is exposed nine inches to twelve inches of solid white pyrite-bearing quartz, with two inches of limonite and bluish quartz against a rotten slate footwall, dipping 70 degrees to south 2 degrees east. A sample from the bottom of the shaft yields (Government Analyst) only traces of gold and silver, but that does not prove the reef unworthy of further testing.

An old shaft adjacent to the above is said to be 40 feet deep, and to have given several small crushings.

GOLDEN GATE.*

This five-acre lease lies adjacent to the Monte Christo, on the eastern side. The workings lie in the south-western corner, and have

* See G.S.Q.P. No. 186.

been all carried out since my last visit. The reef was discovered by prospecting the soil with a pan, the twelve-inch outcrop, two chains west of the present workings, being presumably poor.

Workings.—These workings comprise two shafts 54 feet apart, the eastern (or prospecting) shaft being 30 feet deep, and the western (or whip) 60 feet deep. The shafts are connected at the bottom by an inclined crooked drive, and also at the 20-foot level. The ground between the shafts has been irregularly stoped to the surface. Further sinking is necessary, with drives east and west, and it will probably be necessary to break down several feet of interlacing leaders and country rock.

The prospecting shaft was begun in the footwall, and struck the reef dipping south-eastwards at ten feet. After a few feet the reef became vertical. It here consists of six feet of altered country, traversed by a network of leaders.

The whip shaft was begun in the footwall, and at a depth of 20 feet struck the reef dipping north-westwards.

Reef.—The workings show that there is here a band of altered country (running west 30 degrees south, and practically vertical), with numerous quartz leaders six inches or less in thickness, one or more of which may be auriferous for some yards till intersected by another, which then carries the gold till crossed again itself. Small lenses of quartz beside the main leaders are sometimes found to be gold-bearing. The reef along the bottom workings is poor, but as the owner was unwilling to have it sampled I cannot give the contents.

The presence of a slickensided plane indicates that the leaders are on a fissure zone, conforming in many particulars with the Monte Christo, especially in the country rock, which in the vicinity of the auriferous shoots is brown decomposed sandy slate, but westwards is white clayey, with small nodules of unaltered quartzite.

Ore.—The quartz is glassy, some of it pink, some blue, and some white, but all emitting, when freshly broken, a distinct odour of sulphuretted hydrogen. It has a banded appearance, and seems to be in process of replacing the country rock. The best gold is found where there are strong dendritics (manganese dioxide) in the altered country rock. It is all invisible, occurring most plentifully in bunches of glistening black limonite in the quartz, much of the gold dollied out of the stone being coated with iron oxides. It has also been found that near where the gold is richest is a thin band (up to one foot in thickness) of hard "casing," beyond which the country rock is quite soft and decomposed. As already mentioned, the gold leaves a leader wherever it branches or is intersected by another.

Three auriferous shoots, all pitching steeply south-westwards, have so far been followed between the shafts. In that nearest the whip shaft two feet six inches stone yielded $2\frac{1}{2}$ oz. per ton for a few feet. West of the whip shaft the reef, part of which is pyritous, becomes

very poor, 12 to 18 inches of stone being left standing for that reason, though adjacent thin leaders carry comparatively good gold. Again, six feet east of the prospecting shaft, the main leader pinches down to one inch, and there the country rock is quite unsoftened.

Output.—The following crushings were made at Hart's battery, on Thane's Creek :—

7 Dec., 1903	..	9½ tons crushed for	9 oz. 14 dwt. 1 gr. = 1 oz. per ton
7 Mar., 1904	...	12 " "	17 oz. 10 dwt. 6 gr. = 1 oz. 9 dwt. per ton
27 June, 1904	...	8 " "	19 oz. 18 dwt. 15 gr. = 2 oz. 10 dwt. per ton
13 Feb., 1905	...	15½ " "	39 oz. 4 dwt. 6 gr. = 2 oz. 10 dwt. per ton
		45 " "	86 oz. 8 dwt. 4 gr. = 1 oz. 18½ dwt. per ton

Conclusions.—An inspection of the Golden Gate deposit forces on one's attention the great similarity between it and the Monte Christo in its irregular leaders and zone of altered country rock.

The amount of work done during the last three years is very disappointing, the time having been apparently spent in tracing each leader till the gold left it. To make the shafts and drives approximately 270 tons must have been broken down, and, adding 25 per cent. for stopings, the total quantity raised amounts to 350 tons for 86 oz. of gold, which is equal to 5 dwt. per ton. It would, therefore, at first sight, seem improbable that the reef would pay to work by any method involving the blocking out and breaking down of the whole reef, but it must be remembered that the yield would in all likelihood be considerably increased if the whole of the stone were put through. Further development is by this consideration rendered justifiable.

BIG HILL.*

The present holders have since my last visit opened a drive for 170 feet along the Victoria reef from the old workings to the main adit, and have sunk a 20-foot winze on the same reef, about 70 feet along the drive. The reef has not been broken down, but one or two drill holes were made in it, proving two feet of stone, and the drillings are said to have yielded ½-oz. prospects.

The Big Hill mill now comprises a 16-horsepower portable boiler, a Blake stonebreaker (twelve tons per hour capacity), a Thompson crusher (two tons an hour), and a Wilfley table (one ton an hour). The Thompson crusher has proved a failure, because of so many of the working parts being exposed to the intense cutting action of the sands produced; two-inch manganese steel pins carrying the rollers wear out within a week, as do also one-inch manganese steel carriers (tires).

It is rumoured that a new company has lately been floated in London.

AUSTRALIAN.*

This reef was discovered by Martindale, whose crushings from 1899 to 1903 amounted to—

184 tons for a yield of 325 oz. 14 dwt. 15 gr. = 1 oz. 15½ dwt. per ton.

* See G.S.Q.P. No. 186.

Soon after Martindale's retirement from the claim it was abandoned, because of local impoverishment. It has now (in August, 1905) just been taken up again in a five-acre lease, and there is promise of its being worked on a more extensive scale than heretofore.

SAINT PATRICK.*

The *P.C.*—The St. Patrick is now an extended claim of 400 feet by 400 feet.

The intention of the claimholders to continue the sinking of the No. 5 shaft (Sutton's, 120 feet vertical), to cut the reef at 200 feet depth, has been hitherto frustrated by the serious illness of the manager (Mr. John Clare). Mr. Clare bases his belief in the future of the reef on the fact that a solid body of auriferous pyrite and quartz was coming in at the bottom of the main underlie (No. 4 shaft), when it had to be abandoned because of the large amount (500 gallons) of water met with. Mr. Clare's knowledge of the following crushings from the western end of the reef fortifies him in his faith:—

700 tons for 1 oz. 14 dwt. per ton during 1894-1898,
240 tons for 18 dwt. per ton during 1901-1903.

No. 1 West.—A shaft has been sunk 30 feet, and a drive opened for 30 feet to the south. This drive probably passed over the cap of the reef (pitching westwards), for it was first proved in a gully $\frac{1}{2}$ chain to the east.

No. 1 North.—Since my last visit in 1903 a fourth shaft has been sunk, cutting the "North" reef at a depth of 55 feet. This was continued for 14 feet along the reef on nine inches of stone carrying 15 dwt. per ton. Further prospecting has been abandoned on it for the present, because the workings are almost at the boundary of the *P.C.*, into which the reef dips.

GLADSTONE.*

During the last two years Mr. Kerridge has been receiving Government assistance in proving the Gladstone reef below the old workings. He has struck the reef at 120 feet depth, and reports it payable, but is unable to work it because of lack of capital. The mine has now (August, 1905) been idle for some weeks. Mr. Kerridge has given me the following particulars:—

The main vertical shaft is now 126 feet deep, and there is a 26-foot crosscut to the reef at a depth of 120 feet, with drives twelve feet east and three or four feet west on the reef.

The reef is from six inches to twelve inches thick. A crushing in the small three-head battery at the mine gave—

2 tons for 19 dwt. per ton:

but it is considered that half the gold contents were lost in treatment. The reef cut was believed to be only a branch from the main one, because of a split taking place on the bottom level in the underlie.

* See G.S.Q.P. No. 186.

The continual pumping in the main vertical shaft drained the old workings, and before ceasing operations Mr. Kerridge continued the underlie whip shaft to 80 feet depth, and drove 37 feet east, striking good gold near a crosscourse. Several crushings were obtained, which were not altogether satisfactory because of the difficulty in effecting amalgamation.

GUIDING STAR.

LOCATION.

The Guiding Star reef crosses the main road within 30 chains of Thane's Creek, about $6\frac{1}{2}$ miles west of Pratten. The eastern workings are now included in Costello's selection, the remainder being on the goldfield.

HISTORY.

Gold was first found in loose fragments of quartz in the soil about 1879 or 1880. Payable stone was from the first raised from the No. 1 West; while that in the P.C. was poor, and no other claims seem to have done any work to speak of at the time of the first rush. About 1895 two other shoots of gold were located to the west on the same reef. A shaft has also been sunk some chains to the east of the P.C., but without finding the reef. The whole line is now again deserted. None of the shafts are accessible, and, of course, little as to the nature of the reef can be seen at the surface.

COUNTRY.

The footwall is strongly defined, the country rock below water-level being a dark blue-black, shaly slate, which on the surface weathers light-brown, often with a light-blue interior. No stratifi-

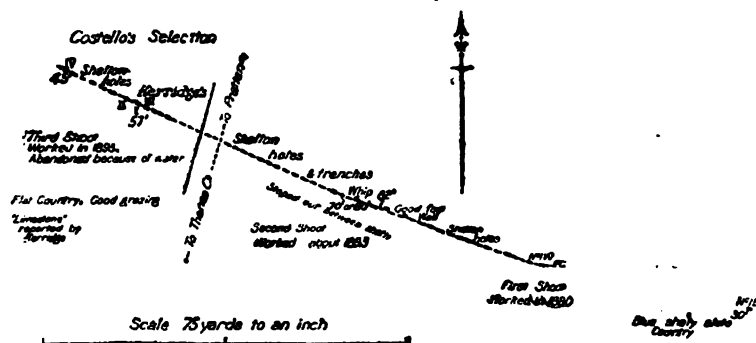


FIG. 2.—SKETCH PLAN OF WORKINGS ON GUIDING STAR.

cation can be made out on the outcrop, though faces which may be joints or even laminations run north-westwards.

REEF.

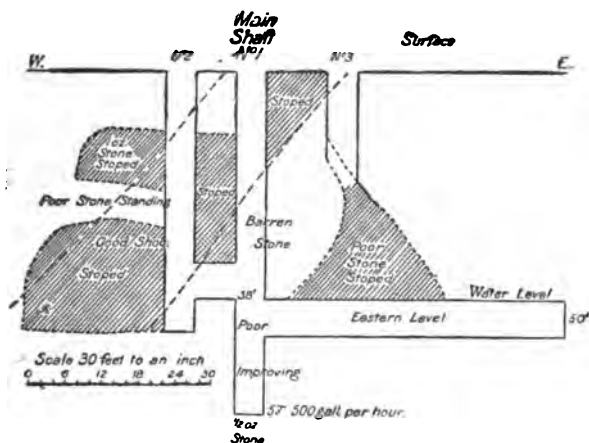
The reef, which has been worked over a distance of ten chains, has a general course of west 20 degrees north, its dip at the surface being 82 degrees to the north 20 degrees east, but it is more nearly vertical at a depth.

First Shoot.—In the No. 1 West (on which claim the discovery was made) the reef averaged 15 inches, and to a depth of 80 feet (10 feet below the water-level) it carried from 10 to 30 dwt. (averaging slightly under an ounce) per ton. The shoot pitched westwards.

In the P.C. shaft, ten feet east of the No. 1 West, the reef widened (to 18 inches at the surface, and to three feet at 36 feet depth), and at the same time the gold contents fell to 3 dwt. per ton, as proved in an eight-ton trial crushing. This shaft is on a slight bend towards the east, which is probably local, the continuation being in all likelihood towards the east-south-east. Owing to this bend, the quartz on the eastern end of the shaft is cracked and internally slickensided; elsewhere it is massive and irregularly laminated by blue seams, indicating it to be partly a replacement reef.

Second Shoot.—This lies about three chains west-north-west of the P.C. Four shafts—the deepest about 70 feet—have been sunk here, and the ground between them has been stoped out over a distance of a chain.

Third Shoot.—This is situated five chains beyond the second. Mr. Kerridge, who did most of the work on this shoot, has given me the accompanying section (Fig. 3), showing the extent of the stopes



* 20-inch hard reef, with plumbago dig, and strong clean walls.

FIG. 3.—KERRIDGE'S WORKINGS ON GUIDING STAR.

between his shafts Nos. 2 and 3. The main shaft is 57 feet deep, the water-level being at 38 feet depth. Mr. Kerridge reports that 20 inches of 1-oz. stone still remains on the 50-foot level in No. 2 shaft, and that the stone in the shaft, continuously improving, runs $\frac{1}{2}$ oz. per ton in the bottom.

Somewhat over 100 tons has been crushed, the last return being for 1 oz. per ton. It will be noticed that the shoot here also pitches westwards. It is understood that the mine was abandoned because of the water encountered (500 gallons per hour).

CONCLUSION.

The above information may be of use to anyone disposed to open up the reef and try it below water-level. With regard to the continuation of the reef eastwards from the P.C., I was informed by Mr. J. Clare, a miner experienced in these fields, and to whom I am indebted for much of the above information, that in prospecting for reefs he has generally found it safe to follow the direction of the overlooking ridge or spur. This agrees with the present trend of geological opinion. It has been shown that in the region north of the Yellowstone Park, in Montana, there is considerable agreement between faults and drainage lines* (and in consequence watersheds).

Mr. Clare spoke of a 2-foot barren reef about a quarter of a mile east of the Gladstone, and possibly a continuation of it, but there was not time for me to see it.

CULLAN'S TWINS.

This is a prospecting area (200 feet by 200 feet) located in a dense scrub on the Thane's Creek Goldfield, $4\frac{1}{2}$ miles west of Thane, the present terminus of the Warwick-Goonidwindi Railway, and 24 miles from Warwick.

The whole of this country has been thoroughly prospected for alluvial, but, owing to its hitherto isolated position, little or no work has been done on the reefs, outcrops of which are reported every few chains to the south of Cullan's.

The discovery of auriferous quartz here was made in March, 1904, through numerous fragments of the stone having been brought to the surface of the soil by the roots of a gum-tree. Trenching in the neighbourhood has resulted in the discovery of three lines of reef.

NORTHERN REEF.

Reef.—The northern reef strikes west ten degrees north, and dips 86 degrees to south ten degrees west. It is massive and well defined; the footwall is slickensided, but the hanging-wall, though easily detached from the quartz, does not show signs of movement. The thickness of the reef varies between nine inches (near the surface) and two feet (in the lower workings), the changes being gradual.

The stone is bluish in colour, and has a glassy appearance; towards the hanging-wall it is to some extent laminated by thin inclusions of the country rock. Galena is said to have been seen in it, as also copper stains, of which, however, I saw none. The gold occurs mostly on yellow "faces" or joints in the quartz, which appear to have been lined with pyrite, deposited since the quartz. It is nearly all found within six inches of the hanging-wall, the quartz on the foot-wall being generally considered barren. No absolutely blank part of the reef has yet been found.

* A Fracture Valley System. Joseph P. Iddings, in Jour. of Geol., V. xiii., 1904.

The gold contents of the reef appear to have been favourably influenced by intersecting or branching leaders (without gold), which glance off to the east-north-east in the footwall, and to the west-south-west in the hanging-wall, as though following a set of parallel fractures. One exception to this rule is to be seen on the 15-foot level, where, at ten feet east of the shaft, the normal twelve-inch reef has increased to 20 inches. Just beyond that point a "horse" comes in, causing the splitting up of the reef into a number of barren leaders, which branch off into the footwall, the main part, six inches thick, continuing on the line of the reef. The reef at this point is not rich.

The country rock is a shaly slate, dipping about 45 degrees to the west 20 degrees south.

Workings.—The main shaft is 50 feet deep. At the bottom a level runs 20 feet to the west, and above it the reef has been, and is being, stoped to within ten feet of the surface on a main shoot pitching westwards, and reaching the surface for some yards west of the shaft. In the bottom level the reef—18 inches wide in the shaft—widens to two feet, but again contracts in the face to twelve inches. A small shoot, two feet in length, is known to occur in the sump. In the western drive on the 15-foot level the reef is only nine inches thick, and can be seen to be pinching upwards; in the eastern drive it opens up to 20 inches at ten feet from the shaft, where, as already explained, a number of leaders branch off, and the main reef is reduced to six inches in thickness.

Output (per Mr. Cullan)—

32½ tons for	31 oz. 16 dwt.	= 19 dwt. 13 gr. per ton
48 "	38 oz. 16 dwt.	= 16 dwt. 4 gr. per ton
20 "		= 6 dwt. per ton.

This last crushing was a trial from all along the bottom, and the return is far too small to pay under the present conditions of working—*i.e.*, with one man below and one man on the brace.

Results.—In spite of the local impoverishment in the 50-foot level, the reef is well worthy of a thorough trial by continuation of the shaft to greater depths, but, unfortunately, the present holders have not sufficient resources to undertake this expense. The work done, though inconsiderable, is sufficient to illustrate the permanency and promise of the reef.

MIDDLE REEF.

Reef.—The middle reef lies 35 yards south of the northern, to which it is parallel. The outcrop exposed in a trench is from two feet to two feet six inches wide.

Stone.—The quartz is bluish and glassy in appearance, the gold being contained in nine inches of its thickness. The richest stone was found at a small bend and break in the reef. The gold has been traced on the surface over a distance of 100 yards.

Workings.—The workings (now flooded) comprise two 14-foot shafts within a few feet of one another, and lying south 30 degrees east of the main shaft on the northern reef, and two trenches, three or four yards in length.

Output.—A trial crushing, from the whole width of the reef exposed in the trenches, of—

24 tons yielded $4\frac{1}{2}$ dwt. per ton.

This is too small to pay expenses (with cartage 6s., and battery treatment 11s. 6d. per ton). Several tons of stone from the shafts now lie at grass.

SOUTHERN REEF.

Reef.—The workings on this reef lie 67 yards south 14 degrees east of those on the middle reef. The reef runs west 22 degrees north, and is practically vertical. Where now exposed, it is about six inches thick. It appears to be pinching towards the west, and may have been thicker in the stoped portion. It is well defined, being on a strong fissure, the hanging-wall having slickensides and corrugations inclined 45 degrees to the west. The main shoot of gold worked for about 35 feet from the surface was found to follow one of these corrugations, as well as a cross leader dipping about 45 degrees to the north-west.

The country rock adjacent to the stopes is sandy, but the same blue slate as near the northern reef is found west of the stopes.

Workings.—The workings comprise two shafts 20 feet apart, the eastern 25 feet, and the western 35 feet, deep. The reef has been stoped out between them and for a few feet on each side, but in the faces and floor is believed to be too poor to exploit.

The reef is worthy of further prospecting by sinking.

Output.—A few tons only have been taken from here, and they are included in the crushings given above.

Brisbane, 4th September, 1905.

PUBLICATION

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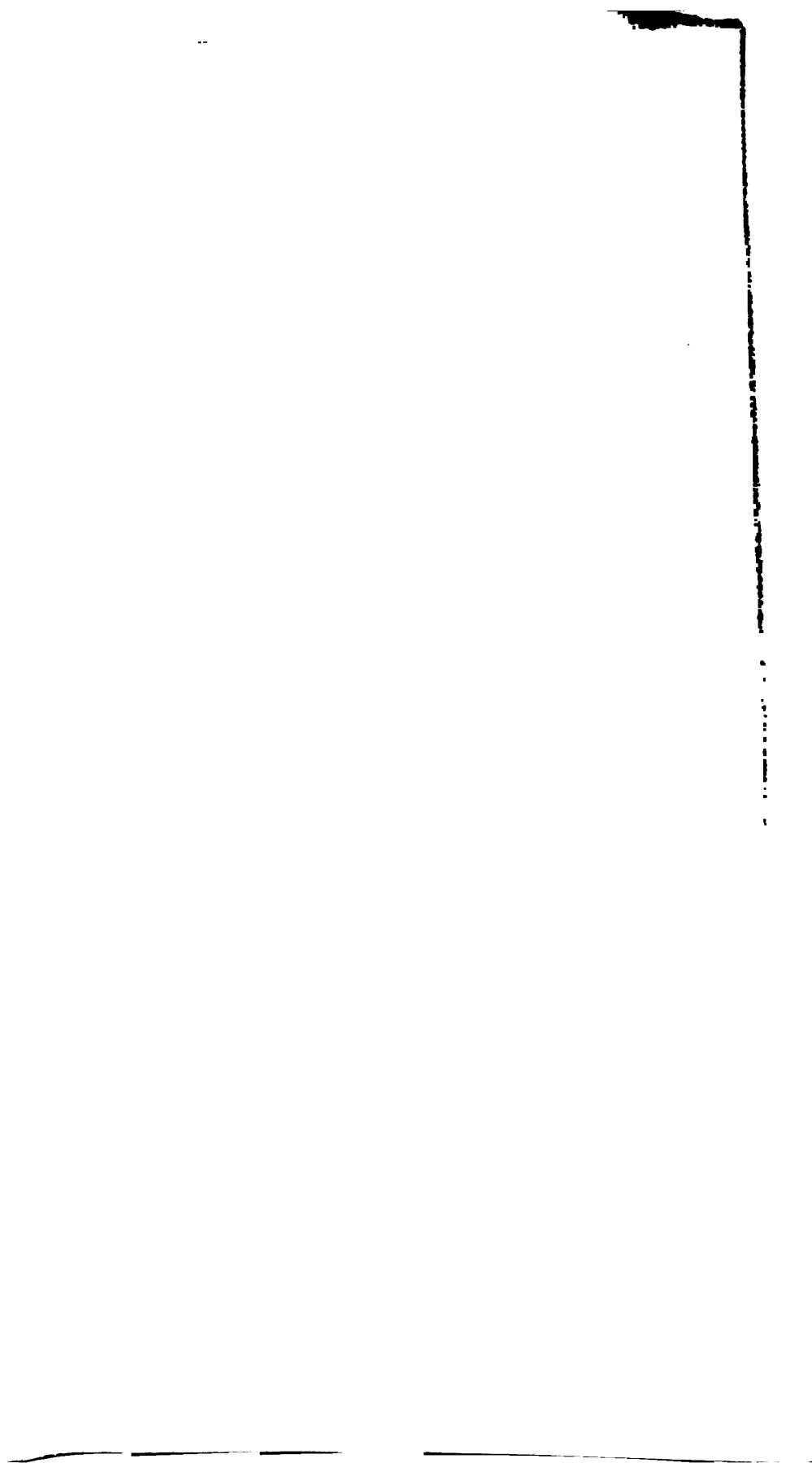
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DEPARTMENT OF MINES.

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(B. DUNSTAN, ACTING GOVERNMENT GEOLOGIST.)

PUBLICATION No. 307.

SOME MINES

IN THE

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(WEST OF MARYBOROUGH).

WITH TWO PLANS.

By B. DUNSTAN, F.G.S.,

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SOME MINES IN THE BURNETT DISTRICT.

1. CALGOA COPPER MINES, NEAR KILKIVAN.

The Calgoa Copper Mines are situated about fifteen miles north of Kilkivan, and about the same distance north-east of Boowoogum, stations on the Maryborough-Kilkivan Railway line. The workings are on Thunder Creek, one of the heads of Calgoa Creek, the latter joining Munna Creek, a tributary of the Mary River. The mines examined are on the Lug-e-nor Block (No. 1415), the Knight of Gwyn Block (No. 1419), and the Mayflower and Eastern Mayflower claims.

On Thunder Creek the copper occurs on the surface as blue and green carbonates, and as black and red oxides, mixed with red and brown oxides of iron, while some distance below the surface the copper occurs as yellow sulphide mixed with iron pyrites. There are about eight well-defined lodes containing copper, some of which have been worked, while, in addition, there is a very irregular formation which contains copper in more or less payable quantities wherever tunnels have been driven into it. The lodes appear to be confined to a belt of country, which, with the adjoining country, is composed of syenitic granite, and acidic dyke rocks traverse the belt and the country outside in all directions.

The workings consist of a number of shafts and drives, which are confined, principally, to the Lug-e-nor and Knight of Gwyn Blocks, the positions of which are shown on the accompanying sketch plan. No. 1 Tunnel, on the Lug-e-nor Block, was opened many years ago, and has penetrated an irregular formation, small veins of copper pyrites showing in numerous places throughout its length. Occasionally the copper is found in large masses, and one of these, now being worked, has produced over 75 tons of copper ore up to the present time,

averaging 18½ per cent. of copper, and having a gross value of £1,300 (*vide* "Returns of Copper Ore received at Waratah, N.S.W.," furnished by Messrs. Turner Bros.).

SOME RETURNS OF COPPER ORE, CALGOA MINES.
(From Waratah, N.S.W.)

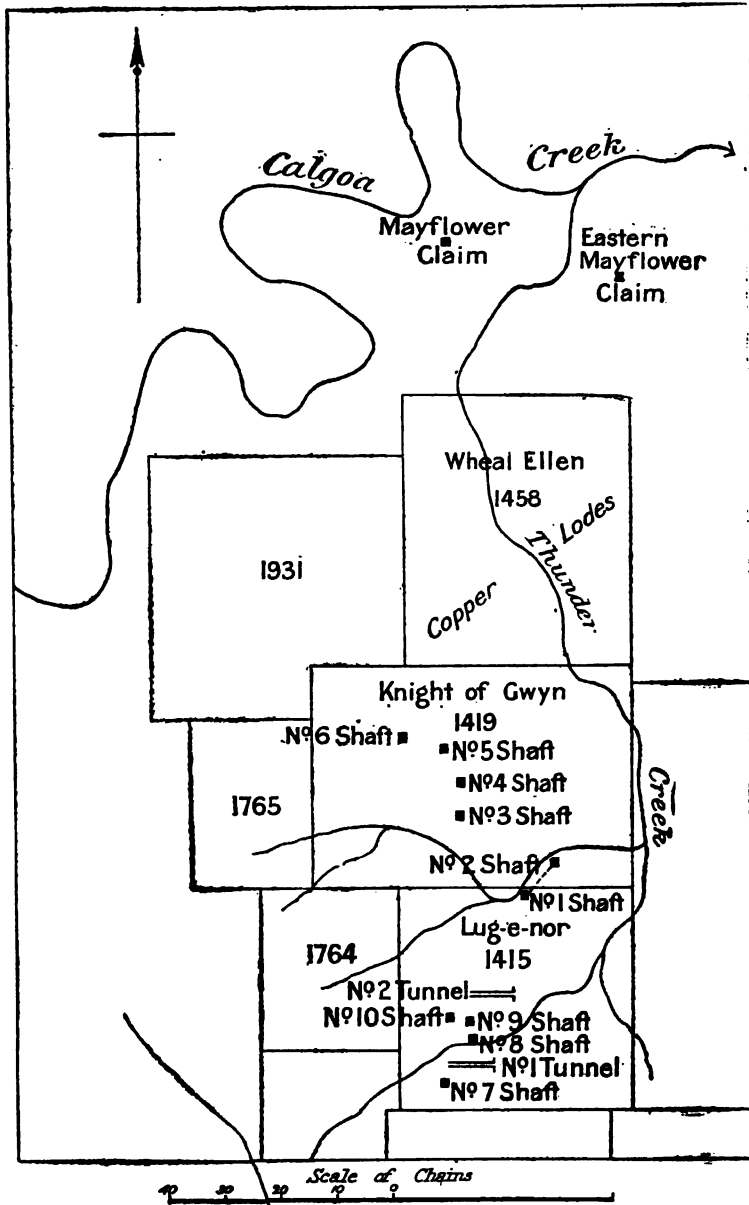
Locality.	Gross Weight.	Assay. Per cent.	Gross Value.	Net Return.	Date.
	T. c. q.		£ s. d.	£ s. d.	
Top Tunnel, No. 1	10 4 2	19	141 0 5	116 8 5	15 Nov., 1905
" "	1 3 0	21½	17 19 6	15 5 0	17 Nov., 1905
" "	11 1 0	21½	181 15 11	152 12 2	30 Nov., 1905
" "	12 15 2	20½	199 17 8	169 7 2	17 Jan., 1906
" "	8 11 0	17½	112 1 6	91 14 5	23 Jan., 1906
" "	10 10 0	13½	102 18 9	77 16 0	8 Feb., 1906
" "	8 12 0	16½	105 19 10	85 2 6	14 Feb., 1906
" "	8 3 2	17½	105 18 10	86 8 5	7 Mar., 1906
" "	5 8 0	21	84 17 0	74 12 0	9 Dec., 1906
No. 2 Tunnel	9 5 0	19½	119 0 2	96 11 9	26 Sept., 1905
"	4 14 0	13	42 4 9	32 3 3	8 Nov., 1905
"	10 6 0	22	168 10 7	144 0 8	7 Dec., 1905
"	13 11 0	9½	88 2 3	56 1 8	3 Feb., 1906
No. 6 Shaft (Knight of Glynn)	3 0 0	24½	53 16 4	73 3 5	17 Jan., 1906
"	3 8 2	14	34 13 6		
No. 1 (boundary) Shaft	5 10 0	23½	96 16 7	82 11 9	8 April, 1905
"	17 16 2	21½	252 7 3	238 12 5	30 Nov., 1905
"	10 7 2	26½	203 15 0	173 1 8	15 Jan., 1906
Calgoa P.C.	2 8 0	26½	45 18 1	40 3 0	8 Feb., 1906

No. 2 Tunnel, also on Luge-nor Block, has been driven fifty-six feet on a small vertical vein of copper ore, and has produced over thirty-seven tons of ore, averaging seventeen per cent. of copper, and having a gross value of over £417.

No. 1 Shaft, on Luge-nor Block, has been sunk to a depth of 100 feet. The lode, which the shaft follows on the underlie, varies up to eight feet in thickness, averages six feet between defined walls, and contains, sometimes, a thickness of one foot of good copper ore. The strike of the lode is E.N.E., the underlie being at angles varying from 45° to 30° from the vertical, the direction of dip being towards the south. Recent returns show that over thirty tons of ore have been raised, yielding, on an average, 23 per cent. of copper, and having a gross value of over £550.

No. 2 Shaft, on the southern boundary of the Knight of Gwyn, has been sunk forty-six feet on the underlie, and has exposed at the bottom about six feet of formation carrying iron pyrites, with small quantities of black oxide of copper and grey copper ore. Kaolin is present on one of the walls of the lode, and is probably a decomposed dyke rock. The lode in this shaft is evidently a continuation of that in No. 1 Shaft, and many features indicate that deeper sinking will probably result in copper being found in payable quantities.

PLAN OF CALGOA COPPER MINES



No. 3 Shaft, on the Knight of Gwyn Block, and about twenty chains north of No. 1 Shaft, is thirty-six feet deep, having an underlie to the south-east at an angle of about 20° from the vertical.

No. 4 Shaft, about six chains north of No. 5 Shaft, is forty-two feet deep. The lode strikes north-east and is nearly vertical, slightly inclining to the south-east. Between the walls there is a formation six feet thick, and in the form of carbonates, red oxide, and yellow sulphide, copper is present in traces. The sulphide at forty-two feet is beginning to show more abundantly, and a few feet further sinking might reveal payable ore.

No. 5 Shaft is north-north-west from No. 4 Shaft, and is thirty feet deep. The lode strikes north-east, and underlies from the vertical at an angle varying from 45° to 30° to the south-east. It is about four feet thick, and on the surface is seen to be an ironstone formation without traces of copper, but the sinking has revealed copper ore, although not yet in quantity.

No. 6 Shaft is situated to the west of No. 5 Shaft, and has been sunk to a depth of seventy feet. The lode strikes north-east, and is vertical, and was worked in places to a depth of thirty-eight feet many years ago. At the bottom a drive has been put in along the lode for a distance of thirty-five feet, and in the face of the drive ten inches of copper ore in a formation four feet wide has been exposed. This shaft could not be inspected, and the information concerning it has been supplied by the owners (Messrs. Turner Bros.). Recently six and a-half tons of ore, averaging nineteen per cent. of copper and having a gross value of £88, was taken out of this shaft, but there is no record showing what was done when these mines were worked thirty-four years ago. Several old shallow workings exist close to the shaft, and from the evidence of the refuse heaps many tons of rich ore must have been removed.

No. 7 Shaft is located on the hill west-south-west from No. 1 Tunnel, and has been sunk to a depth of 110 feet. There is no defined lode in these workings, but the copper occurs in a formation, which probably is a continuation of that penetrated by No. 1 Tunnel, and which it resembles in many respects. Both in No. 1 Tunnel and in No. 1 Shaft there is evidence of the existence of a large body of ore containing copper, which, however, might not pay to send away from the mines for treatment, but which would be a valuable asset if smelting works were established in the locality.

No. 8 Shaft, which was opened years ago, at about the same time as No. 6 Shaft, is situated about ten chains to the north of No. 1 Tunnel. It is ninety feet deep, and underlies from the vertical to the south-east at an angle of about 30° . The lode in the shaft strikes north-east, and consists of about five feet of formation, which in places

is quite barren of copper, but is sometimes composed almost entirely of copper pyrites and iron pyrites. The formation is principally made up of masses of granite, quartz, and a reddish felspar, and has a uniform dip to the south-east. There are two levels at ninety feet, one driven fifty feet to the south-west, the other thirty feet to the north-east, copper pyrites showing in both levels. The ore below ninety feet is said to pinch out to a few inches in thickness, but there is evidently a lot of mineral in the portion of the lode to the south-west.

No. 9 Shaft is about five chains from No. 8 Shaft, and is forty-five feet in depth. Hundreds of tons of ore have been taken out of this shaft, the higher grades of which have been picked out and sent away to smelters. That which is left on the surface is very suitable for machine concentration.

No. 10 Shaft is close to No. 9 Shaft, and is 105 feet deep. There are at grass 200 tons of ore, which contain about three per cent. of copper. The ore originally contained six per cent. of copper, three per cent. of which has been picked out and sent away to smelting works.

Two other copper mines were also inspected—namely, the Mayflower and the Eastern Mayflower. The Mayflower claim is on the northern side of Wheal Ellen Block (1458) and 300 feet north from the boundary of this block a shaft has been sunk to a depth of forty feet. The lode in this shaft strikes east and west, has a nearly vertical dip (6 in 1) to the south, is only a few inches thick, consists of copper carbonates, iron and copper pyrites and black oxide of copper, and has well-defined walls of syenitic granite. At thirty feet a level has been driven to the west for twelve feet, and another to the south for ten feet, in each of which the lode is a few inches thick. Five tons of ore has been taken away for treatment, and is said to have yielded twenty per cent. of copper. Other lodes are exposed on this claim, but, except for a little surface work, and an old shaft which has been sunk to a depth of eighteen feet, they have not been prospected, although of a promising character.

The Eastern Mayflower claim is due east of the Mayflower, and is on the opposite (eastern) side of Thunder Creek (*see* Plan). The lodes trend east and west, and underlie to the south at an angle of about 80°. One shaft, eighteen feet deep, has been sunk on a copper-bearing formation two feet thick, but at a depth of sixteen feet the formation pinched or cut out, and at the bottom there are no traces of copper to be seen.

Besides the quantities of ore which have been recorded from the various workings, there are many tons of good ore ready to be bagged or are bagged ready for transit, in addition to which there are consignments now in transit to the smelting works.

The inspection of these mines were hurriedly made, but the conclusions drawn therefrom show that the mines are in active development, and that they give promise of yielding a large quantity of copper ore in the future.

2. AUBURN FALLS GOLD MINE.

This mine is situated five miles easterly from Glenwood Station, and close to the junction of Cadarga Creek and the Auburn River. Previously an inspection of this mine and those in the vicinity was made by Mr. Ball,* who saw them when they were all being worked. Recently the mine known as the Auburn Falls Gold Mine has again started active operations, and a new shaft (called No. 2) has proved the continuation of the lode (or lodes) in depth.

The outcrops on the surface show that there is a parallel series of lodes striking, approximately, north-west and south-east, and varying much in thickness and inclination.

The shaft known as No. 1 Shaft is sunk to a depth of thirty feet on a lode containing quartz and mispickel, and at the bottom of the shaft a drive has been put in along the lode to the north-west for a distance of twenty feet. The thickness of the lode varies considerably, but in the drive averages about one foot, with a tendency to increase in size below. A sample of stone taken from all the exposed portions of the lode in this drive gave, on assay, one ounce of gold and seventeen dwt. of silver to the ton.

No. 2 Shaft, about 100 yards to the north-east of No. 1 Shaft, has been sunk vertically to a depth of 120 feet, the bottom twenty feet of which underlies slightly to the south-west. The lode here is very similar to that in the No. 1 Shaft, in containing a large quantity of mispickel (arsenical pyrites), while in a crosscut at 100 feet veins of this mineral, sometimes a foot wide, alternate with bands of quartz and of granite, making up a lode formation several feet thick. At the bottom of the shaft the hanging-wall of the lode has not been penetrated, but the mineral is showing very freely in the stone exposed. From this place five cwt. of stone was taken out as a bulk sample, and the assay of a small average sample from this yielded fourteen dwt. of gold and six dwt. of silver.

Trenches have been made across the mineral belt between the two shafts, and several lode formations have been exposed, but, beyond showing their thickness, no work has been done on them.

An inspection was made of Vant's claim, about a quarter of a mile south of the Auburn Falls Mine, now abandoned, and a sample

* Cadarga Creek Mines, Gayndah District, by L.C.B. Queensland Gov. Min. Jour. Ap. 14, 1904 (Vol. 5, pp. 162-3).

taken from the stone at grass gave two dwt. of gold and four dwt. of silver. At Doherty's claim (also abandoned), about 300 yards east of Vant's claim, a lode one foot thick is exposed, and seems to be a continuation of one of the lodes in the Auburn Falls Mine. A sample of the stone from this claim yielded at the rate of seven dwt. of gold and eight dwt. of silver to the ton.

The result of the assays made from the samples of stone from the Auburn Falls Mine are very encouraging, but on account of the presence of so much arsenical pyrites in the lode, it would be advisable to have a bulk sample tested, in order that an opinion may be formed as to the best method of treatment, before any expense is incurred in erecting machinery.

3. DYKEHEAD GOLD MINES.

These mines are situated about eleven miles from Dykehead Station, on Deloura Creek, a branch of the Auburn River, being distant about sixty miles westerly from Gayndah. The country is granite throughout, and near the mines there are masses of kaolin, evidently being decomposed intrusive dykes. The reefs are numerous and very well defined, but at the present time the only work being carried on is that at the mine known as the Dykehead.

On this mine a shaft was sunk some years ago to a depth of 80 feet. This has been cleaned out recently, and the old workings on the reef at a depth of 65 feet below the surface have been re-timbered. This reef has a thickness of about three and a-half feet, and from the small portion exposed it appears to be vertical. The stone tested recently from this reef is said to have yielded four and a-half dwt. of gold to the ton, but the surface stone, when treated some years ago in a battery, is said to have yielded over one ounce of gold to the ton. At the time of the recent examination this reef was not being worked, attention being confined to a second reef picked up in the old workings.

This second reef is about thirty feet south-westerly from the other reef, and is reached by a crosscut ten feet away from the shaft. It strikes north-west and south-east, and is about four feet thick. A trial is now being made of the stone.

Water is troublesome in the mine, and, as one of the walls is of kaolin, close timbering is imperative in keeping the workings from falling in.

The field is worth further prospecting, and, even if the present trial operations result in failure, there is sufficient inducement to warrant the expenditure of capital in opening other reefs on the field.

4. BURNETT SQUATTER REEF, ST. JOHN'S CREEK.

Many years ago the reefs in this locality were being worked very extensively for gold, and recently operations have been started to open up, afresh, the reef known as the Burnett Squatter. From Eidsvold, St. John's Creek is situated to the south-west about sixteen miles distant, and the Burnett Squatter Reef is about half a mile south-west from the village on the bank of St. John's Creek.

The reef averages about eighteen inches in thickness, and is very persistent in its occurrence along the surface for over 400 yards. The strike of the outcrop is east and west, the dip being to the south, with an underlie of 30° from the vertical.

This line of reef was opened several years ago, and when all the free-milling stone above the water level had been taken out, a prospecting shaft was sunk to a depth of 105 feet, but the reef was abandoned. Work is now in progress, and another shaft is being sunk in close proximity to the old one, it being considered that the reef would be found sufficiently rich to be payable with modern methods of treatment. Recent developments have not been advanced sufficiently to warrant an expression of opinion concerning their prospects. The yields of gold from the mines on this reef, taken from the annual reports of the Mines Department, are as follows :—

BURNETT SQUATTER REEF, GOLD RETURNS.

Year.	Tons Treated.					Gold Yield.		
						Oz.	dwt.	gr.
1888	9	...	...
1889	283	...	130	5	12
1890	63	...	23	0	18
1891	8	...	3	10	0

The Springs Gold Lead, on St. John's Creek, was also visited, but the place was found to be uninhabited, and the mines were idle.

5. DON JON BISMUTH MINE, DEGILBO DISTRICT.

This mine was worked years ago for bismuth and for iron, and, after being idle for many years, has quite recently been prospected for bismuth, gold, and copper.

The mine is situated about a quarter of a mile south of Mount Havilah, being distant one mile north of the Biggenden Bismuth Mine, and, in a direct line, about three miles south-south-westerly from Degilbo.

A report on the district was written by Mr. Ball in 1902*, who gives an account of the mine operations up to that time.

* Mount Biggenden Gold and Bismuth Mine, and the Paradise Goldfield. By L.C.B. Brisbane: By Auth., 1902. Pp. 6. pl. 12, maps 2. (G.S.Q.P., No. 173.)

The present operations are confined to an old shaft, which, on being cleaned out, was found to have on one of its sides a lode, or formation, containing very rich bismuth sulphide ore (bismuthinite), an average sample of which yielded thirty per cent. of bismuth and fifteen dwt. of gold to the ton. Further developments at forty feet below the surface exposed a lode containing copper pyrites, iron pyrites, and arsenical pyrites with bismuthinite and native bismuth, but the assays of the stone failed to show more than two dwt. of gold and two ounces of silver to the ton, with $2\frac{1}{2}$ per cent. of copper and $4\frac{1}{2}$ per cent. of bismuth. Work is now proceeding with the object of exposing more bismuth ore, and to see if better prospects can be obtained in other parts of what is undoubtedly a lode several feet in thickness.

6. UNITED REEFS, KILKIVAN.

A casual visit was paid to the United Reefs, being worked for copper and gold, at Black Snake, in the Kilkivan district, but the mine was found to be in the same condition as when Mr. Rands inspected it in 1886.* From the old workings, some ore has been removed, which, it is said, has given satisfactory returns at the smelting works at the mine, and everything is being put in order with a view of working the mine in a thoroughly systematic manner.

7. COMMONWEALTH COPPER MINE, DEGILBO.

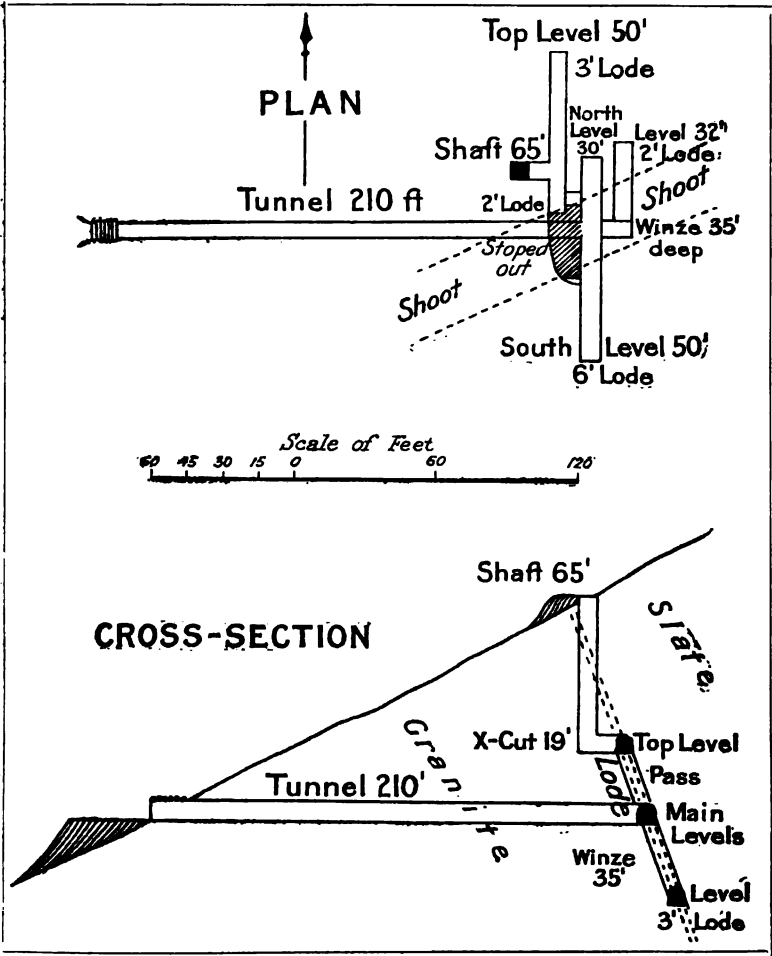
The Commonwealth Copper Mine is situated on the north-west side of Mount Havilah, and is about two miles and a-half to the south-south-west of Degilbo Railway Station, on the Maryborough-Gayndah Railway line. The country in the vicinity of the mines is made up of granite and slate, the copper lodes being a contact deposit between the two formations. To the north of the mine the lode evidently follows this line of contact, but to the south the country is somewhat disturbed, and the continuation of the lode cannot be traced.

The lode trends nearly north and south, the underlie being to the east at an angle of 20° from the vertical. The thickness varies in different parts of the lode, the extreme southern workings showing six feet of ore, whilst in the northern workings the lode is about three feet thick, other intermediate parts varying between one and three feet. Taking the whole of the length of workings, a distance of about 120 feet, the lode would certainly average over two feet in thickness.

The principal lode mineral is arsenical pyrites (mispickel), this occurring throughout the mine, and with this there is red and black oxide of copper (cuprite and tenorite), green carbonate (malachite), yellow sulphide (copper pyrites), iron pyrites, bismuth sulphide (bismuthinite), earthy hematite, and carbonate of lime. The latter

* Geology and Mineral Resources of Kilkivan and Black Snake. By W. H. Rands. Q.G.S.P., No. 28.

COMMONWEALTH COPPER MINE
PLAN AND SECTION OF WORKINGS.



mineral, mixed with clay, occurs in every part of the mine in small quantities, either in the lode or between the lode and the walls, but quartz is found only in traces.

Some portions of the lode are richer than others, and from an examination of the workings, there appears to be a shoot of richer ore dipping to the north-east, while on either side of this shoot, both to the north and south, the ore is comparatively poor.

For the purpose of working the ore, a tunnel, 210 feet long, has been driven into the face of the hill, through granite, meeting the lode on the footwall. From the end of this tunnel a level has been driven thirty feet to the north along the lode, which averages eighteen inches thick. A sample stripped from the exposed portions of the lode on the roof of the level and from the face yielded on assay the following results:—

Gold	...	...	...	...	0 oz. 0 dwt. 14 gr. per ton.
Silver	..	...	...	...	5 oz. 16 dwt. 0 gr. per ton.
Copper	...	...	...	...	1·7 per cent.

The manager of the mine, while considering the sampling would indicate the actual value of the ore taken out from the whole of the lode without including any worthless stone, suggested sampling with a view of showing the value, not of the lode as a whole, but the value of the ore as it would be taken out for treatment, this being the usual practice at the mine. A sample thus prepared by the manager, representing about twenty per cent. of the whole of the stone which would have to be removed in working out the lode, gave the following results on assay:—

Gold	...	...	..	...	Trace
Silver	...	...	...	...	17 oz. 17 dwt. per ton
Copper	...	...	...	...	6·8 per cent.

At the end of the tunnel a level has been driven to the south for a distance of fifty feet, and in this the lode is six feet wide in places, but the ore is poor in quality. On the top of this level the lode becomes smaller and richer, and thirty-three tons of ore have been taken out and sent away to America for treatment. A sample taken from all exposed places along this stope assayed as follows:—

Gold	...	...	...	...	0 oz. 0 dwt. 14 gr. per ton
Silver	...	...	...	...	4 oz. 16 dwt. 0 gr. per ton
Copper	...	...	...	...	1·6 per cent.

The thirty-three tons for treatment was sent to the Tacoma Smelting Company's Works, Washington, U.S.A., and the results furnished by this company show a gross value in gold, silver, and copper of about £5 per ton, the assays furnished showing the following results:—

Gold	...	...	...	...	0 oz. 1 dwt. 0 gr. per ton
Silver	...	...	...	...	16 oz. 0 dwt. 0 gr. per ton
Copper	...	...	...	...	3·5 per cent.
Silica	...	...	...	...	43·6 per cent.
Iron	...	...	...	...	18·6 per cent.

This stope above the south level is on the shoot of ore previously referred to, and is shown on the accompanying plan.

At the end of the main tunnel, a winze has been sunk to a depth of thirty feet on the underlie of the lode, and at the bottom a level has been driven thirty-two feet to the north, across the shoot of ore. The lode exposed in this level averages about one foot ten inches in width, and a sample stripped from the top of the level, along a distance of twenty-five feet, gave the following return:—

Gold	...	...	...	...	0 oz. 0 dwt. 14 gr. per ton
Silver	...	...	...	...	5 oz. 8 dwt. 0 gr. per ton
Copper	...	...	...	...	1·2 per cent.

The manager's samples, five in number, from this level and from the bottom of the winze, returned the following assay results:—

	Gold.				Silver.				Copper.
	Oz.	dwt.	gr.	per ton.	Oz.	dwt.	gr.	per ton.	Per cent.
1	Trace	44	16	0	„	11·4
2	0 0 19 „	21	18	0	„	3·3
3	0 0 15 „	30	9	0	„	2·5
4	0 1 13 „	4	10	0	„	0·6
5	0 2 19 „	2	2	0	„	0·7

Nos. 1, 2, and 3 were taken from the top of the level, No. 4 was from the face of the level, and No. 5 (iron pyrites only) from the bottom of winze and mouth of level.

Close to the tunnel a shaft has been sunk from the surface to a depth of sixty-five feet, crossing the lode at about twenty feet. From the bottom a crosscut was driven to meet the lode on the footwall side (*see* cross-section, attached plan). A level driven north from the shaft has opened up the lode in this part of the ground, proving it to be three feet thick, but very poor in quality.

There is no doubt that the low metal values offer but little encouragement for further development, but at the time of the inspection the mine presented a most unfavourable appearance, as all the rich stone available from the shoot had been sent away for testing purposes. Possibly further prospecting either in depth or along the levels might reveal ore of a richer quality, although such prospecting would be purely speculative.

Taking the average in values and quantities throughout the mine, it may fairly be estimated that a large number of tons of ore could be taken out at a low cost, and would have approximately the following composition:—

Gold	...	...	...	...	...	½ dwt. per ton
Silver	...	...	...	...	...	12 oz. per ton
Copper	...	...	...	...	...	4 per cent.
Bismuth	...	...	...	...	...	2½ per cent.
Silica	...	...	...	...	...	40 per cent.
Iron	...	...	...	...	...	20 per cent.

This would have a gross metal value of, roughly, about £5 per ton, and would represent about twenty-five per cent. of all the stone taken out of the mine.

The method of treatment would require some consideration if the bismuth is to be saved as a product, and with the object of determining what effect concentration would have in enriching the metal contents, a sample of ore weighing about fifteen hundredweights was sent in 1903 to the Krupp Works in Germany for treatment. The assay of the parcel of ore gave the following result, according to the certificate furnished :—

Copper	...	...	...	...	...	6·12 per cent.
Bismuth	...	...	...	...	...	3·33 per cent.
Silver	...	...	...	...	...	16 oz. per ton.

The stone was crushed and dressed, and the report on the trial showed that it is possible to make a fine concentrate high in bismuth and silver and low in copper, whilst a coarser concentrate would be low in bismuth and high in copper. The fine concentrate (< 100 m.m.) was found to contain from 60 to 70 per cent. of the bismuth contents, and from 40 to 50 per cent. of silver contents, whilst the coarse concentrate (> 100 m.m.) contained from 40 to 50 per cent. of the copper contents and low in bismuth and silver.

20739

Queensland.

DEPARTMENT OF MINES.

Queensland Geological Survey.

(B. DUNSTAN, ACTING GOVERNMENT GEOLOGIST.)

PUBLICATION No. 208.

REPORT

ON THE

NORTON GOLDFIELD.

WITH ONE MAP AND FOUR PLATES.

By LIONEL C. BALL, B.E.,

ASSISTANT GOVERNMENT GEOLOGIST.



BRISBANE

BY AUTHORITY: GEORGE ARTHUR VAUGHAN, GOVERNMENT PRINTER, WILLIAM STREET.

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VIEW OF NORTON, GLADSTONE DISTRICT.
LOOKING EAST, FROM THE MINES.

[Tadman, photo.]

REPORT ON THE NORTON GOLDFIELD.

INTRODUCTION.

Norton (or Milton) Goldfield is rectangular in shape, its length east and west being six and a-half miles, and its width north and south four miles. The watershed of the Many Peaks Range forms the eastern boundary; the surveyed boundaries of grazing selections 14v and 15v, Pemberton, the northern; of selection 17v, and portions 291 and 1, Pemberton, the western; and of 1v and 12v, Milton, the southern.

The field is located on the head of the Eastern Boyne River, and is also watered by Norton Creek, in the vicinity of which are the most important workings. Norton township, near the centre of the field, lies eleven miles west-south-west of Bororen Railway Station, on the North Coast line, and twelve miles west of Miriam Vale Station, on the same line. The township is connected by road with Gladstone, the distance to which is 44 miles. A road has also been opened over the Many Peaks Range to Bororen, but, there being excessively steep gradients on both sides of the range, it has been allowed to fall into a state of complete disrepair, and is now only passable for pack horses. An alternative route *via* the Eastern Boyne has been proposed, to escape these gradients, but the distance to the railway will be increased by perhaps ten miles.

This report has been prepared in response to a request made by the local progress committee some two years ago, when many of the mines were in full swing, and when it was believed the publication of the results of an examination of the reefs would be for the benefit of the whole field. Other work prevented my visiting the locality until early in this year, when the field was, unfortunately, going through a period of acute depression. Most of the workings had been abandoned, and were inaccessible, rendering it unnecessary for me to spend more than a few days in examination, especially as the field was geologically surveyed by Mr. Rands in 1885.* Much information was given me by Mr. Carmichael, and every assistance was offered by the few miners still on the field. The returns as to the yearly output have been taken from the Warden's annual reports.

HISTORY.

The first recorded discovery of gold on Norton Creek was made by two brothers named Lett, in 1871, but no records are available as to the progress of the field during the following seven years.

* G.S.Q. Publication No. 21. By William H. Rands, Assistant Government Geologist.

In 1878 there were 60 miners on the Norton Goldfield, and two 3-head stamper batteries were running. In the following year many of the mines reached mundic, and there was an appreciable falling off in the yield (the gold also becoming poorer).

In 1880 the miners numbered 50. It was becoming known that numerous reefs were payable (above the mundic).

During the following three years the population seems to have continuously fallen off, owing to the absence of any treatment works, but in 1884 the Frampton United Company was formed to attempt chlorination (the only other mine then working being the Advance). The company, after two years' profitable battery treatment of their surface stone, began chlorinating in 1887, the five roasting furnaces having cost £3,000. The Advance Company, after sinking to 400 ft., also erected roasting and chlorination plant in 1889, but these seem to have failed, for they were abandoned in 1890. In the same year, when the population had reached 200, the Frampton United, for no given cause, proposed to cease work, and in 1891 their property passed into the hands of the Conran Gold Mining Company. A decline, however, seems to have set in, for in 1893 very little work was done beyond collecting surface stone, and in 1895 reefing was in abeyance. Mr. Carmichael in that year erected a small chlorination plant, but as there are no returns, it was presumably ineffectual. The population had by that time dwindled almost to vanishing point.

In 1899, renewed interest was taken in the field, owing to the erection of a waterjacket blast furnace by Mr. Carmichael. This furnace has not been run by a metallurgist, and has consequently given unsatisfactory results. Two leases were applied for, but no work was done, it is understood, till 1902, a road over the range to Bororen, on the North Coast Railway having been opened with Government assistance in the previous year.

The Marodian Gold Mining Company took up a 40-acre lease in 1903, and during the following year expended £2,800 in crosscutting, driving, &c. Owing, however, it is understood, to speculations elsewhere, the company was compelled to cease operations and seek exemption. The population, which had during 1904 increased to something like 450, at once began to diminish, and there were not more than 50 on the field at the beginning of 1906.

At that time three leases (Carmichael's "Frampton" M. L. 79, Osborne's "Little Wonder" G. M. L. 130, and Osborne's "Bald Hill" M. L. 111) were in force, with seven extended claims ("Goody's," "Brigham Young," Booth's, Morrison's, Macdonnell's, "Sulphide," and "Paddock"). The only mine actually being worked was Morrison's, though there was a man each on the "Frampton," "Brigham Young," Booth's, and Macdonnell's.

GEOLOGY.

THE GRANITE.

The Norton Goldfield is located on the western edge of the Miriam Vale granite area, which covers about 1,000 square miles. This granite has been proved by Mr. Rands to be intrusive into the metamorphosed sediments, which form the hills south and west of Norton. It has not been shown yet whether the Norton granite is of the same age as the rest of the Miriam Vale area, but considerable variations in character are known in different parts, which it may not be possible to explain by differentiation in a single magma. Well-marked changes can be observed in crossing the Many Peaks Range from Bororen Railway Station—both coarsely granular biotite granite and very fine-grained hornblende granite, which in parts would be termed a syenite, being seen. At Norton the granite is a typical fine-grained biotite variety. These remarks are made on the evidence of a macroscopic examination only, this department being without the services of a microscope section cutter.

The Norton area has suffered considerably from tectonic earth movements, which have developed several well-marked sets of joints. The forces causing the movements have not produced extensive single fissures, but instead the rock mass has been blocked out by joints, grouped at a definite angle to the direction in which the forces acted. The grouping may be recognised on reference to the attached map, one set of joints striking west-north-west, another north-west, and a third west (approximately). The joints are most irregularly spaced, being a quarter of a mile apart in one place, while in another a number may occur only a few inches apart. (*See the "Sailor Boy."*)

The joints have afforded passage for circulating solutions from which the metallic minerals have been deposited. Further, being lines of weakness, they have been followed by intrusive magmas forming dykes. The field is thus one immense regular stockwork, and all the joints may have been in direct connection at the time when the ores were deposited.

THE ORE BODIES.

With regard to the reefs, in one or two cases (Chandler's, &c.) central fissures were observed, but in no case were seen the smooth, slickensided walls due to a great fissuring. Some of the leaders (Carmichael's Gully, &c.) have well-defined walls and secondary gangue minerals only, but the great majority of the ore bodies are compound veins or "formations" consisting of altered (quartz, pyrophyllite, and sericite) granite, veined and impregnated by secondary minerals. In these cases there would appear to have been a tearing asunder of the walls of the joint, leaving flakes of the rock imperfectly

attached to either side. Infiltrating solutions would reach these weaker spots, and deposition would there take place, as well as in the more open portions of the joints.

The granite exposed to the action of the solutions has undergone sericitisation (?). The quartz may be unaltered, and the micas can sometimes still be distinguished by their form and cleavage, but the feldspars have been completely altered into granular yellow pyrophyllite (?) ($\text{Al}_2\text{O}_3 \cdot 4\text{SiO}_2 \cdot \text{H}_2\text{O}$).

Mr. Rands distinguished between the reefs north and south of Norton Creek, finding those on the south to contain, with one exception (the All Nations), little or no calcareous matter in the gangue, and as early as 1880 it was reported that more free gold could be got from the mundic (to a depth of 200 ft.) in those reefs on the north side than from those on the south, where mundic was reached at between 30 and 40 ft. from the surface. Since then it has been repeatedly stated that the ores north and south of the creek are radically different. This, however, is not the case, for mispickel, pyrite, quartz, blende, chalcopyrite, grey-ore, galena, and calcite go to make up ore bodies on both parts of the field. One or other mineral may, however, be abnormally abundant or altogether absent from any particular reef or portion of reef selected. Thus, mispickel and galena are absent from some, while calcite, very abundant in one or two localities, is very scarce in most of the ore bodies. The occurrence of gypsum (at the Little Wonder) is interesting, as showing comparatively modern metasomasis of one of the gangue minerals—i.e., calcite. Contrary to my expectation, it cannot be definitely affirmed that the order of deposition of the various minerals has been the same for all the reefs, though it does appear to have been the same in adjacent joints—e.g., Chandler's and Little Wonder, and Goody's and Brigham Young. More generally, the arsenopyrite or pyrite has been first precipitated and followed by galena, quartz, blende, and chalcopyrite.

LINES OF REEF.

The reefs are taken in alphabetical order, and described under the older or more common name. Mention of the few claims and leases at work is made in the record of location of and workings on each reef.

ADVANCE (G.M.L. 104).

Location.—The P.C. lies about $\frac{1}{4}$ -mile north-east of the school; the No. 1 South-east is 2 chains distant from the P.C.; the No. 2 South-east is $1\frac{1}{2}$ chains from the No. 1 South-east; and the No. 1 North-west is $1\frac{1}{2}$ chains from the P.C. The workings are on Gold Mining Lease 104.

Eastern
Boyne River

Sketch Plan
REEFS

NORTON GOLDFIELD

Town Reserve



Workings.—The P.C. shaft (poppet-legs), at which steam winding plant was installed in 1888, is 396 ft. deep, the last 76 ft. having been subsidised by the Government. The shaft is now hidden by the ruins of the mullock tip, no work having been done here for the last fifteen years. There are levels 8 ft. to the north-west and south-east at the shaft bottom, and a main drive beneath the No. 1 South workings, at a depth of 270 ft. It is understood that there are stopes for 50 or 60 ft. north-west of the shaft at the different levels, and the Warden, in 1885, reported that a lot of stone was taken from the 320-ft. level.

No. 1 South shaft is about 200 ft. deep. Some stoping was done here between 1881 and 1885.

No. 2 South whim shaft has been officially reported to be 300 ft. deep (water now at 40 ft. from the surface). There are drives extending 100 ft. to the south on the 100 and 200 ft. levels. Some stoping was also done here.

Pot-holes extend from No. 1 North-west for 3 chains up the gully to the Emu reef, and for several chains beyond, but nothing payable was reported.

Reef.—The reef runs N. 38° W. It is vertical to a depth of 200 ft., but underlies 76° to south-west from there to 300 ft. It intersects the Emu line about 10 chains north-west of the Advance P.C.

The ore-body is, as a rule, a wide "formation," 4 to 9 ft. across in the P.C. and 5 ft. in the No. 2 South-east. This consists of altered granite, reticulated and sometimes almost replaced by quartz, the vein being then from 2 to 18 in. in thickness (Rands). The country rock is a jointed granite, which appears to have been highly silicified near the reef.

Parallel reefs occur at $\frac{1}{2}$, 2, and $2\frac{1}{2}$ chains south of the Advance line, but they have not been tested.

Ore.—The quartz carries much mispickel and pyrite and some blende, chalcopyrite, and galena, "with a great deal of calcareous matter, chiefly calcite." "At the bottom of the shaft of the prospector's claim a dark-grey mineral comes in, which consists of antimony sulphide—gold 11 dwt. per ton and silver 2 oz. 15 dwt. per ton, mixed with much earthy matter." The sinking, during 1886, between 320 and 396 ft., was reported to be nearly all mundic.

"The gold runs in shoots, which have a southerly underlie." The contents fell considerably on mundic being struck. In the P.C. the 6-in. reef at the surface carried 15 oz. per ton., and the 2 to 3 ft. reef at the 200-ft. level carried up to 3 oz.; but "at the 130-ft. level the lode is made up of a calcareous rubble containing gold, but not in such quantity as where the reef is more solid." The gold disappeared at about 300 ft. from the surface, but the 5 ft. of calcareous ore at the

shaft bottom contains 8 dwt. per ton. The north-western end of the reef seems to have been poor, the returns even from the No. 1 North-west having been unpayable.

Output—

Claim.	Year.	Material.	Amount.	Total yield.	Yield per ton.	Authority.
			Tons.	Oz dwt.	Oz dwt.	
Hickeys ...	1879	...	?	...	15 10	Carmichael
	1880	...	7	44 17 =	6 8½	"
	"	...	25	52 6 =	2 2	"
	"	Tailings	0½	4 6 =	5 15	"
	"	"	0½	0 16 =	0 18	"
	"	...	100	257 10 =	2 11½	"
	"	...	80	136 10 =	1 14	"
	"	...	31	284 0 =	9 3½	"
	"	...	3	12 0 =	4 0	"
	"	Screenings	14	10 0 =	0 14	"
	"	...	4½	56 0 =	12 9	"
	"	...	20	143 0 =	7 3	"
	"	Casings	17	16 7 =	0 19	"
	"	Surface	5	4 13 =	0 18½	"
	1881	...	52	78 10 =	1 10	"
	"	Tailings	22	52 5 =	2 7½	"
	"	"	4½	3 15 =	0 16½	"
	1882	"	3	2 9 =	0 16	"
	"	...	88	208 0 =	2 7½	"
	1884	...	100	186 0 =	1 17	"
No. 1 S.E.	"	...	116	202 14 =	1 15	Rands
	1880	Surface	5	12 10 =	2 10	Carmichael
	"	...	26	122 10 =	4 14	"
	"	...	12	36 0 =	3 0	"
	"	Tailings	2	0 18 =	0 0	"
	1881	...	15	23 6 =	1 11	"
No. 2 S.E.	1882	...	8½	13 0	1 10	"
	"	...	8	16 6	2 1	"
	1887	...	41	71 15	1 15	"
	1881	...	30	60 15	2 0½	"
	1882	...	110	219 0	2 0	"
	1884	...	68½	219 5	3 4	"
No. 1 N.W.	1888	...	8	29 0	3 12½	"
No. 1 N.W.	1881	...	20	13 4	0 13	"
No. 2 N.W.	"	...	9	11 11	1 6	"
Partial total ...			1,057	2,604 18 =	2 9½	

ALL NATIONS (M.L. 98).

Location.—Nearly ¾-mile south by east from the school, and 2½ chains south-south-west of the south-western corner of M. L. 79. The workings are in the north-western part of M. L. 98, which was abandoned during 1905, and they lie 5 chains W. 25° S., from the Frampton main shaft.

Workings.—The main workings comprise two 60-ft. shafts, a chain apart, with communication at the deepest point. Osborne's whip, the eastern shaft, was sunk to 30 ft. fifteen years ago. Two chains west of the second shaft there are a few pot-holes in which, however, nothing can be seen of the reef.

Much trouble was experienced with water in sinking here, and it now stands in the shafts at a depth of 25 ft.

Reef.—The reef runs E. 12° S. On its line of continuation a 2-ft. calcite lode, dipping 80° to N. 16° E., has been exposed in the bed of Norton Creek, a few chains above the eastern boundary of M. L. 98.

The reef is only 4 in. wide, but the returns have been good. There is "no mullock between the mundic and the walls" (Rands).

The country rock is a very hard and fine-grained granite.

Ore.—The ore from Osborne's whip is said to have carried much silver and lead. That at the brace of the western shaft consists of sulphides, laminated with and crystallised in calcite, the cleavage faces of which are much curved. These sulphides consist of crystallised pyrite and blende (both in the quartz veins and in bunches of calcite), and a fair amount of galena. "The mundic assayed from 2 to 3 oz. per ton . . . worth only from £2 to £2 10s. per oz." (Rands). In 1880 the Warden reported that the miners were on pay-stone.

The water here was, contrary to the usual experience in this part of the field, quite free from acid, owing to the presence of much calcite in the reef.

Output—

Year.	Amount.	Total Yield.	Yield per ton.	Authority.
	Tons.	Oz. dwt.	Oz. dwt.	
1882	12	15 12 =	1 6	Carmichael
" " " " " "	5	26 12 =	5 6½	"
18¼/1905	32	... =	1 14½*	Osborne
" " " " " "	12	... =	6 0 †	"
" " " " " "	12	... =	1 6 "	"
" " " " " "	9½	... =	4 0 †	"
" " " " " "	9½	... =	3 3½*	"
" " " " " "	5½	... =	11 0 †	"
" " " " " "	5½	... =	1 7½*	"
" " " " " "	5½	... =	6 0 †	"
Partial total	76	151 4 =	2 0	

* Gold.

† Silver.

BALD HILL (M.L. 111).

Location.—Within ¼-mile east from the school. The lessees (M. L. 111) are exempt for six months, from January, 1906.

Workings.—The Bald Hill shaft lies E. 9° S. from the school, and E. 67° S. from the post office. It is 60 ft. deep, and there is a drive running 65 ft. west. Work ceased here at the beginning of 1905, and water now stands within 40 ft. of the surface.

The new shaft in the gully (lying E. 9° S. of the school, and E. 46° S. of the south-western corner peg of M. L. 104), is 50 ft. deep, but is flooded below 30 ft. It is proposed to continue the sinking to 120 ft., to test the ground with a view to smelting. Alongside this shaft is a cutting 15 ft. deep, 4 ft. wide, and 10 ft. into the hillside.

The old adit is 1 chain east of the new shaft. It runs in about 50 ft. to the south, and a drive then continues east 20 ft. to the air

shaft, and for 20 ft. beyond, when it bends to the south-east and continues 20 ft. further. The air shaft was sunk 50 ft. below the level of the adit. From the bottom a drive was opened back 30 ft. to the west to Carmichael's winze, and the ore then stoped up. Carmichael's winze at the end of the adit was 25 ft. deep originally.

Reef.—The Bald Hill shaft (as well as the other) is on a line of altered country ("formation") running E. 8° S., and traceable for miles. In the cutting adjacent to the new gully shaft 4 ft. of this formation has been exposed, but it has not a promising appearance.

Ore.—The ore at the brace of the Bald Hill shaft consists of quartz carrying only mispickel and pyrite, with stains of scorodite (arsenate of iron), and it appears to have occurred as ill-defined leaders in a granite formation, but Captain Osborne tells me that in the face of the drive there is 9 ft. of dense pyrite, carrying—

Copper = $1\frac{1}{2}\%$; and gold = 19 dwt. per ton.

The new shaft in the gully has produced chiefly rotten granite, iron-stained along cracks and joints, but showing also some scorodite. A 2-in. leader of sulphides must have been struck in the shaft. This contains a fair amount of chalcopyrite with mispickel, pyrite, and quartz, but no calcite. In the cutting near the shaft can be seen flat joints dipping 20 degrees to the north, while the master joints run about south.

In the adit drive can be seen gossany decomposed granite, with brown (oxide), and green (sulphate) iron stains. One lenticular patch of poor ore shows up to 7 in. decomposed pyrite and quartz. It is understood that the ore occurs scattered through the 12 ft. rotten formation in masses of a few hundredweights at most. Carmichael's winze was on a richer patch, covering an area of 1 yd. by 3 yds. at the intersection of joints. The body yielded only 25 tons of ore, and then passed into stringers on all sides. A private analysis of Carmichael's ore gave—

Copper = 3%; gold = 1 oz. 4 dwt. per ton; and silver = 7 oz. per ton.

The copper has here been precipitated in bunches by the action of the kaolin of the decomposed granite. At a very slightly lower depth the granite has been found to be simply veined with quartz carrying coppery pyrite.

Output—

Claim.	Year.	Amount.	Treatment.	Product.	Analysis Product.	Authority.
Carmichael's Winze	...	Tons. 25	Smelted	2 tons matte	Per ton. Gold = $3\frac{1}{2}$ oz. Silver = 48 oz. Copper = $9\frac{1}{2}\%$	Carmichael
Osborne's	...	30	...	...	...	"
		30	...	...	...	"
		30	...	...	...	"

BRIGHAM YOUNG (TADMAN'S TAPAUTOHAUNGA).

Location.—A little over $\frac{1}{2}$ -mile south-south-west of the school, and 3 chains N. 35° W. of Goody's main shaft.

Workings.—An old underlie, originally 35 ft. deep, has been continued into the new workings.

Tadman's new vertical shaft is 30 ft. south-west of the underlie, and is 44 ft. deep. At the bottom is a crosscut northwards to the reef, along which a drive has been carried eastwards to the underlie (at 15 ft.), and 20 ft. beyond.

Adjacent to these workings opencuts have been opened on parallel leaders at opposite ends and sides of the main reef.

Reef.—Runs E. 7° S. (dipping 1 in 6 southwards) for a chain, and breaks over to the south at the eastern end, and to the north at the western.

The reef in the 44 ft. level gradually increases from 6 in. at the underlie shaft to 18 in. (solid sulphide) in the eastern face, where it is bending round still more nearly eastwards. The reef was probably small near the surface where richest.

The country rock is granite, jointed parallel to the reef, with $\frac{1}{4}$ -inch leaders on the joints. The walls, though well defined, are not slickensided, and the ore is "frozen" to the hanging-wall. A diorite dyke 8 ft. to the south of the reef on the crosscut strikes west 10 degrees south.

Ore.—The ore in the face on the 44-ft. level is dense pyrite, with bands of other sulphides (25 per cent. galena in one place). A specimen is said to have assayed—

Gold = 4 oz. 8 dwt. ; and silver = 8 oz. 17 dwt. per ton.

There were 8 or 9 oz. yields on top.

In my sample (93), from the 3 tons at grass, as well as from the face, the ore is laminated to some extent, and consists of:—

- (1) Quartz and pyrophyllite (5 per cent.)—silica (besides the original) crystalline in vugs, in dogtooth form in veinlets, and as crystals on the pyrite, in which is also some secondary silica. Quartz can also be seen to have replaced country rock.
- (2) Blende (20 per cent.)—chiefly in the interspaces between the pyrite crystals, but also along fissure zones, and occasionally as crystals in the dogtooth quartz. Seldom on the same side of veinlets as the galena.
- (3) Pyrite (50 per cent.) straited cubes.

(4) Galena (25 per cent.)—on irregular lines in crystal form among and around which pyrite has been deposited, but never blende; cleavage faces sometimes curved; seldom massive.

(5) Malachite (traces).—Stains in a leached vug in ore specimen.

The order of deposition of the minerals has thus been—(i.) pyrite, (ii.) galena, (iii.) blende, (iv.) quartz, (v.) malachite.

Assay (Government Analyst)—

Gold = 1 oz. 0 dwt. 9 gr. per ton
Silver = 12 oz. 11 dwt. per ton.

Analysis (Government Analyst) not expected to be available for some months.

The above approximate estimation would indicate the presence of—

Zinc = 13 %
Lead = 21½ %

Output—

Claim.	Year.	Amount.	Total yield.	Yield per ton.	Authority.
Present face 44 ft. 1-vel		Tons.	Oz. dwt.	Oz. dwt.	Carmichael Tadman
	1881	9	23 5	2 11½	
	1895	1¼	...	1 13*	
		...	...	11 0†	
Partial total	...	10½	25½ 0	2 8½	

* Gold.

† Silver.

CALCITE.

Location.—2 chains south of the post office.

Workings.—The shafts have long been abandoned.

Reef.—Strikes W. 40° N.

Calcite blocks on the surface prove that the lode is at least 9 in. wide.

Remarks.—A 3-in. or 4-in. leader parallel to and 1 chain north-east of the above has been sunk on to a depth of 200 ft.

CARMICHAEL'S GULLY (G.M.L. 104).

Location.—The mouth of the adit is 2 chains E. 5° S. from the north-western corner of M.L. 104.

This adit has hitherto been considered to be on the Advance line.

Workings.—For 30 ft. (including 15 ft. cutting) the adit runs E. 27° S., and then about 105 ft. E. 10° S. The reef is, therefore, not the Advance.

Reef.—The strike is easterly and westerly, and the dip is 1 in 6 to the north.

The leader is 2 to 4 in. wide, well defined. An 8-in. reef is reported in the well just outside the adit.

Ore.—It consists mostly of calcite, with black laminations parallel to the walls; very little sulphide. The calcite is sometimes rose-coloured, and its cleavages surfaces are generally curved.

CHANDLER'S (M.L. 79).

Location.—The main adit is situated in M. L. 79, about 5 chains south of the northern corner.

Workings.—The workings on Chandler's reef extend right across M. L. 79, and beyond it to Norton Creek, where an adit was begun but was abandoned because of the smallness of the lode. The reef has been opencut to a depth of 20 ft. from the eastern boundary of the lease for $1\frac{1}{2}$ chains towards the west. A shaft was sunk in it for mundic ore, but now contains water to within 10 ft. of the surface.

The reef has been guttered at intervals above and to the west of Chandler's adit, which is in about the centre of the lease (4 chains from the eastern line).

The main adit crosses the Little Wonder reef at 20 ft. from the mouth, and a short distance north-west of the intersection of that reef with Chandler's. At 30 ft. from the mouth, Chandler's reef was cut, and it has been followed for 150 ft. to the west.

Further, a shaft, known as the Frampton North or Osborne's No. 1, has been sunk 25 ft. on a rich patch at the junction of this reef with the Frampton. This shaft has, during the past two years, been continued by Captain Osborne an additional 75 ft., but the timbers having been drawn it is now inaccessible. From Captain Osborne I understand that drives have been opened 65 ft. east and 32 ft. west, proving an average width of 18 in. of pyritic material worth 11 dwt. per ton.

The only work now going on along the line is in Chandler's adit, where one man is "mullocking down" from the old surface workings. The method of breaking down has hitherto been by overhand stoping, but it is proposed to connect with the old workings 30 ft. above the adit, and then sink a new shaft.

Reef.—The general strike is east and west, though at the eastern end it is east-south-east. The dip is northwards 1 in 10 vertical in the main adit, but at the eastern end it is vertical. It intersects both the Little Wonder and Frampton's reef.

In the old surface workings west of the adit the reef "varied in thickness from 1 to 3 ft." At the adit it is 6 in. thick, and that may be taken as a general average—between 3 in. and 12 in.; but the footwall granite is in places also veined and patched for 12 in. from

the centre of the reef. The walls are good, there being generally 2 in. decomposed granite on the hanging (northern) wall, but there is also a central fissure, which increases the probability of permanence.

The auriferous shoots on this line generally pitch westwards, but except at the Frampton North no gold has been found west of M. L. 79.

Ore.—Marcasite (?) from the reef has been assayed for 1 oz. and $1\frac{1}{2}$ oz. per ton, and the ore from the adit, when hand-picked, has yielded 3 oz. 6 dwt. on crushing, while the "seconds" concentrated gave 4 oz. 5 dwt. per ton. "The gold . . . is worth only from £2 to £2 10s. per oz."

In my sample (96) from the whole surface of the 25 tons at grass the ore is evidently replaced shattered granite. It consists of—

- (1) Quartz and pyrophyllite (60 per cent.)—quartz, both original and in glassy dogtooth form, almost free from pyrite.
- (2) Pyrite (20 per cent.)—modified cubes disseminated through quartz.
- (3) Mispickel (5 per cent.)—small blady crystals disseminated through quartz.
- (4) Chalcopyrite (5 per cent.)—irregular branching forms in quartz, probably infilling spaces in same, associated with massive mispickel; also as bunches in the blende.
- (5) Blende (10 per cent.)—almost massive, interbanded with pyrite, and also crystallised in quartz (?).
- (6) Grey ore (traces)—in white quartz.
- (7) Scorodite (traces)—encrusting cavities.
- (8) Azurite (traces)—stains in cavities.
- (9) Malachite (traces)—stains in cavities.

Order of deposition: (i.) Mispickel, (ii.) pyrite, (iii.) quartz, (iv.) blende, (v.) chalcopyrite, (vi.) grey ore, (vii.) scorodite, (viii.) azurite, (ix.) malachite.

Assay (Government Analyst):—

Gold = 3 oz. 3 dwt. 4 gr. per ton
Silver = 4 oz. 17 dwt. per ton.

Analysis (Government Analyst) not expected to be available for some months.

The above approximate estimation would indicate the presence of—

Zinc = $6\frac{1}{2}$ %
Copper = $1\frac{1}{2}$ %

Output—

Year.	Amount.	Material.	Treatment.	Yield.	Yield per ton.	Authority.
	Tons.			Oz. dwt.	Oz. dwt.	
1879	4 $\frac{1}{2}$	...	...	3 7	0 13 $\frac{1}{2}$	Carmichael
"	45 $\frac{1}{2}$	...	...	98 0	2 3	"
"	35	...	...	60 3	1 14 $\frac{1}{2}$	"
1880	14 $\frac{1}{2}$	...	...	22 13	1 11 $\frac{1}{2}$	"
"	15	...	...	13 16	0 18 $\frac{1}{2}$	"
"	14	...	...	22 10	1 12	"
1882	10	Surface	...	10 9	1 1	"
"	30	...	Chlorinated*	=	2 0	"
"	200	...	"	...	...	"
"	1 $\frac{1}{10}$§	...	...	...	1 15†	"
"	...	...	...	...	10 0‡	"
"	25	...	At grass	...	...	"
Partial total	170			293 1=	1 14 $\frac{1}{2}$	

* The second attempt to chlorinate was reported to be a failure because of the presence of zinc

† Gold.

‡ Silver.

§ From the adit—treated in England. Contained zinc = 22%.

DENT'S.

Location.—Half-mile south-west of Brigham Young.

Output.—Five tons crushed are reported to have yielded—

Gold = 1 oz ; silver = 32 oz. per ton.

DYKE.

Location.—On Norton Creek, about 10 chains above M. L. 98.

Workings.—None.

Reef.—There is here a 6-ft. dyke striking W. 10° N. parallel to the jointing of the granite. On the northern side is 4 to 6 in., and on the southern side 2 to 4 in. calcite, containing a little mineral—i.e., sulphide.

EMU (G.M.L. 104).

Location.—Lies 5 chains S. 44° W. from Marodian shaft, and 3 chains N. 10° W. from the P.C. Advance. The workings are near the centre of G.M.L. 104.

Workings.—The main whip shaft is 160 ft. deep, and the eastern whip shaft, which has been filled in, 200 ft.(?) deep. The workings extend for 3 chains west of the intersection with the Advance line of reef, which is about 10 chains north-west of the Advance P.C.

Work ceased here four years ago, and consequently the shafts cannot be examined.

Reef.—The strike is W. 4° S. and the dip about 1 in 10 or steeper northwards.

The reef's thickness, varying between 1 and 6 in., averages 4 in.

Several outcrops (of ochreous and honeycombed quartz) with an east and west course have been tried on the western side of the ridge, on which are situated the Emu and Advance workings.

Ore.—The ore is a “quartz and calcite gangue containing the mundic,” and “went from 1 to 6 oz. per ton, being richer when smaller.”

A very rich shoot of gold lay east of the whip shaft, from which yields of 10 oz. (plus 2 oz. in tailings) per ton were obtained. West of the whip shaft was a blank to the creek, $2\frac{1}{2}$ chains distant. At that point is the intersection with the Advance line, beyond which there were yields of 3 oz. per ton—presumably on No. 4 W., where paystone was reported in 1880.

Output—

Claim.	Year.	Crushing.	Yield per ton.	Authority.
			Oz. dwt.	
P.C. ...	1880	26 tons for 40 oz.	1 11	Carmichael
	1882	9 tons for 42 oz. 9 dwt.	4 14	„
		32 tons for 36 oz. 15 dwt.	1 3	„
1 W. Emu ..	1880	$8\frac{1}{2}$ tons for 17 oz. 10 dwt.	2 1	„
		14 tons for 42 oz. 14 dwt.	3 1	„

Partial total, $89\frac{1}{2}$ tons for 179 oz. 8 dwt. = 2 oz. per ton.

FRAMPTON (MARTIN'S OR CONRAN'S, M.L. 79).

Location.—Nearly $\frac{3}{4}$ mile south-south-east from the school. The workings are now included within Carmichael's M.L. 79, of 10 acres.

Workings.—Most of the preliminary work was done by the Frampton United Company, who took up the ground in 1884. By 1886 they had prospected the whole length of Martin's reef, in places for 150 ft. from the surface. The claim, still known as Frampton's United, was worked from 1888 till 1891, by Conran's G.M. Co. Everything appears to have been going smoothly in 1889, but in 1890 it was proposed to cease work. Exemption was secured for six months in the following year, and subsequently tributes were let. The company seems to have passed out of existence in 1892, and since then the ground has been in Mr. Carmichael's hands.

The main shaft, at which there is a head frame, is 320 feet deep, but it is now falling in. There are understood to be levels at 40 ft., 90 ft., 180 ft., etc.

The south-eastern shaft is $\frac{1}{2}$ chain to the south-east of the main shaft.

Frampton's first shaft is 2 chains to the north-west—and was originally 60 ft. deep.

Another shaft, 4 chains to the north-west (within $\frac{1}{2}$ chain of the boundary of the lease), is 60 ft. deep.

There are open cuts between Frampton's first and the south-eastern shafts, and on the leader for 1 chain from the main reef, beyond which only a mass of leaders could be found.

Plate II.



Some 5 or 6 chains from the Frampton workings is the Frampton North shaft (Osborne's), originally 25 ft. deep, but lately continued 60 ft. by Captain Osborne.

Reef.—The strike is E. 38° S. from the north-western boundary of the lease, and the dip is 1 in 12 to the south-west. This reef intersects Chandler's.

"Martin's reef can be traced for a quarter of a mile along the summit of the ridge." There were good walls in the main workings, but the reef splits up into numerous leaders (carrying gold when honey-combed), within a chain of the main shaft on the south-east and in G.M.L. 130 on the north-west. "On Martin's claim, towards the west, it is as much as 8 ft. thick, and the mundic is 3 ft. thick at the bottom of Mr. Frampton's shaft, about 40 ft. deep." In the north-western shaft an 8-ft. formation, pitching southwards, was found to a depth of 60 ft. Below it the mundic ore carried only 6 dwt. per ton. About $\frac{1}{2}$ chain south-east of this shaft can be seen 3 ft. of poor ore (quartz and calcite) with beautifully slickensided western wall but indistinct eastern wall. The ore here is reported to be rich wherever honey-combed. Beyond this again 2 ft. of surface was proved to carry 8 or 9 dwt. About $\frac{1}{2}$ chain south-east of Frampton's first shaft a branch leaves the main reef for 2 chains, and the whole of the country between the two reefs (up to $\frac{1}{2}$ chain across and 6 ft. deep) has been crushed. Below that "mineral" was found.

On the 90-ft. level the arched stringer is said to be 9 in. thick, and to carry 7 oz. per ton, but near the surface it increased to 2 ft. and yielded 14 dwt. per ton. There is "no mullock between the mundic and the walls" (Rands).

The Frampton North shaft, as first sunk, was on a rich patch, but the continuation is believed to have been poor, the gold being in the sulphides.

Ore.—Near the surface the stone assayed 2 to 4 oz. per ton, and the lower levels were reported to be richer than the upper in 1888, but the gold is said to have been lost at 200 ft. Mr. Carmichael believes that the shoot pitches southwards, and was sunk through.

In 1890, Mr. Rands* inspected the 180-ft. level, and found 8 to 16 in. mundic (iron and arsenical pyrite, blende and galena), occurring in shoots in greyish mullock, between hard granite walls.

The ore is evidently from a "formation"—quartz stringers and replacements, with lines of blende and bunches of pyrite and galena and patches of calcite. A few tons were handpicked and sent away by Captain Osborne.

The water in this mine carries much acid.

* G. S. Q. Publication No. 58. Annual Progress Report of William H. Rands, Assistant Government Geologist, for 1890.

Output—

Claim.	Year.	Yield.	Material.	Treatment	Yield per ton.	Authority.
Constitution	1879	18 tons for 18 oz. 8 dwt.	...	Crushed	Oz. dwt. 0 17	Carmichael
	1879	6½ tons for 18 oz. 9 dwt.*	...	"	2 19	
Frampton's United	1886	Several good crushings	...	"	1 to 3 oz.	Warden
	1886	300 tons	Tailings	Chlorinat'd	2 or 3 oz. (expect'd)	
Constitution	1886	70 tons for 210 oz.	Mundic	"	3 0	Carmichael
	1886	120 tons for 190 oz.	Brownstone	"	1 12	
	1887	263 tons for 551½ oz.	...	"	2 3	
	1887	1,000 tons for 2,553 oz.	...	Chlorinat'd	2 11*	
Conran's ...	1888	? tons for 3,702 oz.†	...	"	...	Warden
	1892	47 tons for 85 oz. 18 dwt.	...	"	1 16½	
	...	33 tons for 55 oz. 17 dwt.	...	"	1 14	
	...	87 tons for 45 oz. 8 dwt.	Surface	"	0 10½	
N.W. of Frampton Shaft	...	12½ tons for 17 oz. 8 dwt.	...	"	1 8	Carmichael
	...	300 or 400 tons	Surface	Crushed	3 or 4 dt.	
No. 1 Frampton or Empress of India	...	Tailings	Same	Cyanidied	0 5	Warden
	1879	23 tons for 38 oz.	...	"	1 13	
	...	30 tons for 62 oz. 3 dwt.	...	"	2 1½	
	1880	12 tons for 5 oz. 10 dwt.	...	"	0 9	
	...	21 tons for 33 oz. 3 dwt.	...	"	1 11½	
	1881	10 tons for 12 oz.	...	"	1 4	
Nil Desperandum	...	9 tons for 13 oz. 10 dwt.	...	"	1 10	Warden
	...	16 tons for 29 oz. 15 dwt.	...	"	1 17	
	1879	6½ tons for 8 oz. 13 dwt.	...	"	1 6½	
	...	12 tons for 26 oz.	...	"	2 3	
	...	30 tons for 62 oz.	...	"	2 1	
Partial	1890	10½ tons for 23 oz. 6 dwt.	...	"	2 2½	Warden
	total	2,199 tons for 4,198 oz. 18 dwt.	...	"	1 18	

* Valued at £4 3s. per oz.

† Valued at £4 3s. 6d. per oz.

GALENA (MORRISON'S, BOOTH'S).

Location.—The old Silver Mine shaft lies S. 16° W. from the school-house, at a distance of a little over ½ mile.

Morrison's and Booth's claims are presumably on the continuation of this reef, and are here included. Morrison's shaft lies S. 18° W. from the school, at a little over ½ mile, S. 36° W. from the School of Arts, and about 4 chains west of the old Silver Mine. Booth's shaft is 5 chains west of Morrison's, and ½ mile south-south-west of the school.

Workings.—At the old Silver Mine there are a 20-ft. shaft and trenches, which have been abandoned for many years.

Morrison's shaft is 90 ft. deep, and is now open to 70 ft. below the surface, where the water is standing. There are stopes on the eastern side to 35 ft., and on the western (8 ft. in) to 50 ft. from the surface; while a new stope on the eastern side from 40 to 70 ft. extends back for 15 ft. At the 70-ft. level is a prospecting drive running 60 ft. to the east in search of a shoot.

Booth's shaft is 37 ft. deep (now flooded); and at a depth of 36 ft. there is a drive to the east 5 ft. long. The reef has been trenched and opencut at intervals on the claim. It is proposed to sink a couple of chains to the east of the present shaft, in an old opencut known to have given rich returns and believed to be on a golden shoot.

Reef.—The Galena reef at the Silver Mine strikes W. 4° S., any variation from the vertical being northwards. At Morrison's it runs east and west, underlying 1 in 10 v. southwards; and at Booth's it runs E. 3° N., and dips 1 in 20 southwards.

It is 10 in. to a foot in width at the Silver Mine, and "is separated from the granite walls by a casing of mullock consisting of broken granite, the distance between the walls being three to four feet." On Morrison's bottom level the ore body consists of 2 ft. 6 in. granite, with 3 in. pyrite on the footwall, 1 in. pyrite on the hanging-wall, and leaders throughout. On the 40-ft. level the walls, 2 ft. 6 in. apart, are slickensided. Above this level the reef is on the footwall, but below it is on the hanging-wall. The drive at the 70-ft. level shows 12 in. of fissured granite, with lines and bunches of sulphides.

The walls of Booth's formation are 3 ft. 9 in. apart near the surface.

Ore.—The ore raised from the old Silver Mine contained a good deal of galena, and owing to the high proportion of silver the bullion was worth only £1 10s. per oz.

That from Morrison's shaft consists of—quartz and pyrophyllite, 50 per cent.; pyrite, 40 per cent.; galena, 5 per cent.; and blende 5 per cent. (in bunches). It is said that the surface stone yielded 3 oz. per ton, and that as soon as the blende came in the gold fell to 1 oz. per ton. My sample (99) of the $3\frac{1}{2}$ tons concentrates (from 7 tons "seconds") at the battery consists of a very fine mixture of pyrite and galena.

Assay (Government Analyst):—

Gold	= 2 oz. 8 dwt. 9 gr. per ton.
Silver	= 5 oz. 3 dwt. 13 gr. per ton.

Analysis (Government Analyst) not expected to be available for some months.

The ore from Booth's shaft is a decomposed granite veined with quartz carrying sulphides, in which it is rather richer than that from Morrison's shaft. In my sample (94), from the $\frac{1}{2}$ ton of "firsts" still at the shaft, the ore consists of:—

- (1) pyrite (50 per cent.)—irregularly in galena.
- (2) galena (25 per cent.)—massive, filling cracks in the original quartz-pyrophyllite rock, also blady forms in pyrite and as bands.
- (3) blende (10 per cent.)—this small quantity occurs with the quartz in pyrite.
- (4) quartz (10 per cent.)—filling interspaces in pyrite, and including pyrite crystals and occasional veins.
- (5) chalcopryrite (5 per cent.)—irregular forms filling interspaces in the galena.

Order of deposition: (i.) Galena, (ii.) pyrite, (iii.) chalcopryrite, (iv.) quartz, (v.) blende.

Assay (Government Analyst):—

Gold = 17 dwt 4 gr. per ton.

Silver = 20 oz. 3 dwt. per ton.

Analysis (Government Analyst)—not expected to be available for some months. The metal contents, according to the above rough estimation, should be: Lead = $21\frac{1}{2}$ per cent.; zinc = $6\frac{1}{2}$ per cent.; copper = $1\frac{3}{4}$ per cent.

In my sample (102), from the 10 tons of "seconds" at grass, the ore, consisting of partly replaced pyrophyllite-quartz country, comprises:—

- (1) quartz (65 per cent.)—massive, bluish veins.
- (2) blende (20 per cent.)—crystals in quartz along fissures (?) and also massive including crystals of pyrite.
- (3) pyrite ($12\frac{1}{2}$ per cent.)—crystals disseminated in pyrophyllite quartz country, in vein quartz and in blende.
- (4) galena ($2\frac{1}{2}$ per cent.)—on pyrite, leached.

Order of deposition: (i.) Pyrite, (ii.) blende, (iii.) quartz, (iv.) galena.

Assay (Government Analyst):—

Gold = 15 dwt. 4 gr. per ton.

Silver = 11 oz. 12 dwt. 19 gr. per ton.

Analysis (Government Analyst)—not expected to be available for several months. The metal contents, according to the above rough estimation, should be: Zinc, = 13 per cent.; lead, = 2 per cent.

Output—

Claim.	Year.	Crushing.	Yield per ton.	Authority.
Silver	1879	15 tons for 26 oz. 15 dwt.	Oz. dwt. 1 15 $\frac{1}{2}$	Carmichael
Mine	1880	3 tons for 3 oz. 15 dwt.*	1 3 $\frac{1}{2}$	„

Partial total, 18 tons for 30 oz. 10 dwt. = 1 oz. 14 dwt. per ton.

* This gold was worth only £1 10s. per oz.

Morrison has lately sent 8 tons of "firsts" to Aldershot, expecting 3 or 4 oz. per ton, but the returns are not yet available to me. The 17 tons "seconds" from the same had been crushed locally, yielding $3\frac{1}{2}$ tons of concentrates (see analysis above).

Booth has just shipped 5 tons of "firsts" for treatment, and 10 tons of "seconds" lie at grass (see analyses above). A previous shipment of 30 cwt. had yielded:—

Gold = 2 oz. 9 dwt.; and silver = 15 oz.

together with these values:—

Lead = 13s. 6d.; zinc = 6s. penalty; and iron 4s. premium.

GOODY'S (CARMICHAEL'S).

Location.—The main workings are $\frac{3}{4}$ mile slightly west of south from the school.

The ground was held as an extended G.M. claim till 1892, when the liquidation of Conran's G.M. Co. took place. Carmichael's present extended claim, which includes all Goody's workings, is exempt, owing to dissensions among the claimholders.

Workings.—These comprise old trenches at the eastern end, to be seen for many chains beyond the New Constitution line.

Carmichael's original shaft, 30 ft. deep, is about $2\frac{1}{2}$ chains from the junction with the New Constitution. The reef has been deeply trenched for 2 chains to the north-east of the shaft, and occasional crushings have been taken out from between 5 and 15 chains from this trench.

Goody's whip shaft at the north-western end of these workings is 90 ft. deep. Carmichael's new shaft, 60 ft. deep, a chain to the east, is being sunk through worked ground, to reach the auriferous shoot proved from the whip shaft. It now holds 5 ft. of water, but is understood to be nearly at the level of the shoot. The outcrop of the reef has been practically all removed from this vicinity—an opencut extending $\frac{3}{4}$ chain east of Carmichael's shaft.

Goody's main shaft (provided with poppet-head and 6-h.p. boiler and winch) is 3 chains north-west of the whip. It is 210 ft. deep, and water now stands at 70 ft. below the surface. At the 90-ft. level drives run 40 ft. north-west (on payable stone cut off in the face) and 40 ft. south-east (where a dyke was met and driven through). It is proposed to crosscut south-east of the dyke for a second reef found on the surface. On the 150-ft. level drives run 40 ft. north-west and 50 ft. south-east (where the dyke was again met), and beyond the dyke a stope extends for 50 ft. on a fine reef.

Reef.—The reef runs W. 41° N., meeting the Constitution about 4 chains west of the eastern shaft on that line. In Goody's the underlie is 1 in 10 v. to the south-west.

The mundic reef in Goody's shaft is said to be as much as 3 ft. wide. In Carmichael's old shaft it was a foot wide, and gave yields of 3 oz. per ton.

For 3 chains beyond the trench at Carmichael's shaft no work has been done, as, though the formation is good-looking, it carries little gold. A shoot of gold occurs to the east of Carmichael's whip, and 2-oz. stone is reported to have been plentiful. The "reef has not been worked to the north-west of Goody's, but it is believed to break up into parallel 'splices,' each slightly in advance of the preceding, to the south." The shoots have been found to cut out on floors, and are connected by clay seams along the same.

Ore.—The sinking in Carmichael's shaft was cellular quartz veined, altered kaolinised granite. The stone here is understood to be practically free from blende, and it is therefore proposed to smelt it. Mixed sulphides occur, however, 30 ft. to the west and 2 chains to the east.

At Goody's the country rock of the ore formation was removed in the mine, and the blende was picked out on the surface. In my sample (95), from the ton at grass, the ore, showing no banding but fairly plentiful leached cavities, consists of:—

1. Pyrite (50 per cent.)—massive and crystallised. Sheets of pyrite cross cavities and connect with crystals.
2. Blende (20 per cent.)—crystallised in quartz and filling interspaces between pyrite and quartz crystals; also drusy on quartz crystals in cavities and often on opposite sides of veinlets.
3. Galena (10 per cent.)—crystals surrounded by pyrite.
4. Mispickel (10 per cent.)—very fine grained crystalline or massive in siliceous country.
5. Quartz (10 per cent.)—filling interspaces between pyrite crystals and also crystalline in the same spaces; perfect crystals in galena. One vein of dogtooth structure was deposited on pyrite, after which galena filled in the interspaces in the quartz.
6. Grey ore (trace)—crystals in quartz veinlets, especially where there is a coating of blende.

Order of deposition: (i.) Mispickel, (ii.) galena, (iii.) pyrite, (iv.) blende, (v.) grey ore, (vi.) quartz.

Assay (Government Analyst):—

Gold	=	19 dwt. per ton.
Silver	=	16 oz. 8 dwt. per ton.

Analysis (Government Analyst)—not expected to be available for some months. The above rough estimation indicates the presence of: Zinc=13 per cent., lead=8½ per cent.

At about ½ chain south-east of the main shaft is a 12 ft. dyke dipping south-east, beyond which, instead of a single reef, there are two about 25 ft. apart at the dyke, and coming together within 2 chains from it. On the surface the north-eastern "formation" is 18 in., and the south-western formation 2 ft. 6 in. wide. They were both rich, and have been open cut to their junction, but on the 90-ft. level only the southern reef has been cut, and, though very small, it

was rich in gold. On the 150-ft. level the reef east of the dyke is lenticular in form, 15 in. wide at the centre, and tapering upwards and lengthways to 6 in.

Output—

Claim.	Year.	Crushing.	Yield per ton.	Authority.
P.C. ...	1880	12 tons for 15 oz. 8 dwt.	Oz. dwt. 1 5½	Carmichael
		20 tons for 42 oz.	2 2	
No. 1 ...	1882	7½ tons for 15 oz.	2 0	"
	1880	78 tons for 129 oz.	1 13	
		2 tons (mundic) 17 dwt.	0 8½	
		50 tons " 99 oz. 10 dwt.	2 0	
	1881	14 tons " 9 oz. 10 dwt.	0 13½	
	1901	parcels sent Aldershot		

Partial total, 188½ tons for 311 oz. 5 dwt. = 1 oz. 14 dwt. per ton.

HAN'S BIG REEF (M.L. 98).

Location.—A little over ¾ mile south-south-east of the school.

The workings are now within the boundaries of M.L. 98, but were formerly included in forfeited G.M.L. 128.

Workings.—Trenches, 5 to 10 ft. deep and 1½ chains long, have lately been opened at the south-eastern end. Osborne's shaft, reported to be 60 ft. deep, is a chain west of the trench; it is inaccessible, owing to there being 30 ft. of water in it. Beyond the shaft to the north-west unsuccessful holes have been opened for 2 chains (*i.e.*, to within 5 chains S. 35° E. of Frampton's).

Reef.—The strike is about N. 50° W., and the underlie is 80° to 85° to the south-west.

The width of the formation in the trenches is about 18 in.

Ore.—The brown stone in the trenches is a cellular siliceous rock, evidently an altered pyritous granite "formation." The sulphides from the lower level consist of, say, pyrite 70 per cent. and galena 20 per cent., and they carry, it is said, 13 dwt. per ton (the gold being worth, however, only £2 per oz.).

Output—

Year.	Crushing.	Yield per ton.	Authority.
1880 ...	7 tons for 5 oz. 3 dwt.	Dwt. 14½	Carmichael
	14 tons for 7 oz. 8 dwt.	10½	
1882 ...	7 tons for 6 oz. 2 dwt.	17½	"
1883 ...	8 tons for 6 oz.	15	
1884 ...	13 tons for 10 oz. 19 dwt.	16½	"
1886 ...	5 tons for 4 oz. 4 dwt.	16½	
1887 ...	15½ tons for 8 oz.	10½	"
1904 ...	29 tons for 7 tons concentrates		

Partial total, 69½ tons for 47 oz. 16 dwt. = 14 dwt. per ton.

LITTLE WONDER (G.M.L. 130).

Location.—Slightly over $\frac{1}{2}$ mile south by east from the school. The workings are included in G.M. Lease No. 130, of 20 acres, which adjoins M.L. 79 on the west.

Workings.—The reef has been open cut for a distance of 5 chains, beginning at a chain from the north-western boundary of M.L. 79, and it has been pot-holed for a further distance of 5 chains to the north-west.

Conran's shaft, 1 chain from the south-eastern end of the cut, is 50 ft. deep.

The Little Wonder shaft, a chain to the north-west, was originally 30 ft. deep, but Captain Osborne has sunk it to 65 ft., opening drives for 76 ft. to the east and 60 ft. to the north. It is now half full of water.

The ladder-way, or western shaft, 120 ft. deep, a chain to the north-west, could not be inspected because of foul air. Captain Osborne reports having at the 60-ft. level driven east 45 ft. and west 65 ft.

A line of reef has been exposed on M.L. 98, on the bluff above Norton Creek, east of M.L. 79. This is believed to be the continuation of the Little Wonder, the same line having been open cut to 20 ft. depth about 2 chains south-east of Chandler's adit.

Reef.—The reef on G.M.L. 130 strikes N. 58° W., dipping steeply north-east at the Little Wonder and south-west at the ladder-way shaft. On M.L. 98 the strike is N. 65° W., and the dip is 85° to the north-east. The reef was traced along the surface for over 300 yards by Mr. Rands.

The reef was 18 in. wide at the south-eastern end of the main workings (Rands). Captain Osborne reports the average width of the lode in the Little Wonder shaft to have been 14 in. (pyritous stone averaging $3\frac{1}{2}$ oz. per ton). In the eastern drive here the average width of the lode was 9 in., and the western 4 in. ($2\frac{1}{2}$ oz. per ton). The average width of the lode in the ladder-way shaft eastern workings was 6 in., and in the western workings 8 in.

At the north-western end are no defined walls, there being a big "formation" of leaders, "frozen" to the decomposed granite. Generally, however, there is no mullock between the mundic and the walls.

The best shoot of gold is understood to be just to the south-east of the Little Wonder shaft.

The country rock is a very hard granite, and on M.L. 98 it can be

seen to be considerably jointed, the master joints running parallel to the reef, while there are also horizontal joints and two sets of subsidiary joints making an angle of 45° with the reefs.

At the eastern end of the main workings on M.L. 130 there are two reefs lying parallel to the Little Wonder, one 20 ft. to the south-west and a second $1\frac{1}{2}$ chain beyond. The first has been trenched for about a chain from M.L. 79.

Ore.—The ore consists, on M.L. 98, of 6 in. of promising gossan on the surface; sulphides, carrying 13 dwt. gold, are reported to occur a few feet below; while $2\frac{1}{2}$ -oz. stone was raised from the trench 2 chains south-east of the adit. At the main workings the quartz carries much pyrite and a little chalcopyrite, while in one place crystals of gypsum were found between the quartz and pyrite. The gypsum is evidently a secondary product formed by the action of sulphuric acid (set free by the decomposition of pyrite) on the calcite. The coarser pyrite has generally been found here to be poorer than the finer, which has assayed "a little over 1 oz. of gold and 4 oz. 17 dwt. of silver per ton." "The gold is worth only from £2 to £2 10s. per oz" (Randa).

In my sample (97), from the 20 tons "seconds" at the Little Wonder shaft, the ore (granite "formation") consists of:—

1. Quartz and pyrophyllite (70 per cent.)—quartz crystallised in cavities, and crystalline in pyrite interspaces. Some cellular.
2. Mispickel (15 per cent.)—disseminated through the pyrophyllite-quartz rock between the two minerals; also banded with pyrite.
3. Pyrite (15 per cent.)—crystallised on pyrophyllite, on dog-tooth quartz in mispickel, and also in sheet form.
4. Blende (traces)—occasional fillings in quartz veinlets and pyrite.
5. Chalcopyrite (traces)—irregularly in quartz and filling cavities in pyrite.

Order of deposition: (i.) Mispickel, (ii.) pyrite, (iii.) quartz, (iv.) blende, (v.) chalcopyrite.

Assay (Government Analyst):—

Gold	= 1 oz. 9 dwt. 19 gr. per ton.
Silver	= 3 oz. 16 dwt. 9 gr. per ton.

Analysis (Government Analyst)—not expected to be available for some months. Only traces of zinc, lead, and copper are to be hoped for.

Output—

Claim.	Year.	Crushing.	Yield per ton.	Authority.
Osborne's Frampton	1880	4 tons for 5 oz. 14 dwt.	Oz. dwt gr. 1 8½ 0	Carmichael
		20 tons for 21 oz. 4 dwt.	1 1½ 0	
		22 tons for 28 oz. 15 dwt.	1 6 0	
North End	1879	15 tons for 27 oz. 18 dwt.	1 17 0	"
		38 tons for 60 oz. 0 dwt.	1 11½ 0	
		21 tons for 23 oz. 0 dwt.	1 3½ 0	
		27 tons for 40 oz. 5 dwt.	1 9½ 0	
		22 tons for 17 oz. 0 dwt.	0 15½ 0	
Osborne Shoot No. 1 W.	1881	9½ tons for 29 oz. 10 dwt.	3 2 0	"
	1882	3½ tons for 9 oz. 1 dwt.	2 14 0	
	1879	8 tons for 8 oz. 0 dwt. mundie	1 0 0	
		4½ tons for 4 oz. 10 dwt. (7 oz. stone)	1 0 0	
Little Wonder Shaft	1903	9 tons 2 cwt. treated for gold	1 10 17	Osborne
	26/5/03	6 tons 12½ cwt. treated for silver	4 19 0	
		6 tons 12½ cwt. treated for gold	1 13 7	
	4/8/03	5 tons 11 dwt. treated for silver	Nil	
	25/7/04	15 tons 3 cwt. treated for gold	1 8 19	
Eastern drive, Little Wonder Shaft	19/2/03	2 tons 10 cwt. treated for silver	3 11 14	"
		2 tons 10 cwt. for gold	2 19 14	
	2 tons 5 cwt. for silver	7 3 14		
	4/8/03	8 tons 8 cwt. for gold	3 18½ 0	
	4/8/03	8 tons 8 cwt. for silver	8 18 0	
Ladder-way Shaft	4/8/03	8 tons 1 cwt. for gold	3 18 0	"
		8 tons 1 cwt. for silver	6 10 0	
	25/4/04	10 tons 15 cwt. for gold	3 8 0	
	25/7/04	2 tons 18 cwt. for silver	7 3 0	
		2 tons 18 cwt. for gold	3 12 0	
Eastern drive, Ladder-way Shaft	25/7/04	13 tons 15 cwt. for silver	8 13 0	"
		13 tons 15 cwt. for gold	6 18 9	
	26/5/03	5 tons 1 cwt. for silver	8 4 0	
Western drive, Ladder Shaft	25/7/04	17 tons 4½ cwt. for gold	2 10 0	"
		17 tons 4½ cwt. for silver	4 7 14	

Partial total, 303 tons for 653 oz. = 2 oz. 3 dwt. per ton.

MAHOGANY (G.M.L. 104).

Location.—The shaft is on M.L. 104, 4 chains S. 4° E. from the Marodian main shaft.

Workings.—These—a shaft, a trench ½ chain to the south-east, and a hole 1 chain to the north-west have all fallen in. In addition to them there is an adit (in the bank of the creek at the north-western end), where some gold shed from the reef was obtained.

Reef.—The line of strike is N. 52° W.

Though 4 ft. of mundie was reported at 40 ft. depth, only fragments of "formation" (granite, with bunches of calcite and impregnations of pyrite) can be seen at the brace. Further, the yield given below is said to have been really from a small leader running with the sulphides.

Plate III.



MARODIAN MINE, NORTON GOLDFIELD. [*Tadman, photo.*]

Output—

Crushing.	Yield per ton.	Authority.
15 tons sulphides gave 10 oz. The gold was worth £3 10s. per oz.	13½ dwt.	Carmichael

MARODIAN (G.M.L. 104).

Location.— $\frac{3}{4}$ mile north-east from the school-house.

The lease (M.L. 104, of 40 acres) was taken up in 1903, but work ceased towards the end of 1904, after £2,800 had been expended in crosscutting, driving, and in machinery, etc.

It was under exemption during the whole of 1905.

Workings.—The Marodian shaft (originally the Who'd-ha'-Thought-It) is said to be 320 ft. deep, and has been cleaned out and re-timbered to 200 ft. from the surface. During 1904 the following work was done. Levels were opened at depths of 120 and 200 ft. At the former depth a crosscut was carried 50 ft. to the south, and drives were opened at 15 ft. from the shaft for 65 ft. east and 100 ft. west. At the latter level crosscuts were carried 15 ft. to the south where a drive was opened 45 ft. east, and 10 ft. north where a drive was opened 96 ft. west. No work has been done since July, 1905, and water is now at 40 ft. below the surface.

The Marodian reef and the diorite dyke have been trenched for about 2 chains east of the main shaft.

Reef.—The strike is east and west, the underlie 10° north. The reef meets the Who'd-ha'-Thought-It a few feet west of the main shaft, and at somewhere about 200 ft. in the shaft.

The "formation" (granite with quartz) is said to be 3 to 4 ft. wide on the 120-ft. level, "and of this 1 ft. could be considered crushing material, but at the surface and at the 300-ft. level there was only 9 in. to 1 ft." (manager). The reef runs along, and is "frozen" to, a diorite dyke in the lower levels, and was lost in diorite (faulted ?) in the old western workings.

Ore.—In the western shaft at the 150-ft. level, and in the main shaft at the 200-ft. level, the reef, the gangue of which was chiefly calcite, gave very fair prospects when first cut, "but below the reef decreased in contents to a few pennyweights of gold per ton." (Rands).

Gold has not been found in the reef beyond 2 chains east of the main shaft, and when Mr. Rands inspected the mine no payable gold was found between the 290-ft. and 320-ft. levels, where the Who'd-ha'-Thought-It leader is present.

The gangue is chiefly calcite and the gold occurs in the sulphides. In my sample (100), from the 15 tons at grass from the 200-ft. level, the ore, of which the sulphides show some banding, consists of:—

1. Pyrophyllite (30 per cent.)—of the original country.
2. Quartz (30 per cent.)—dogtooth layers on the country rock.
3. Calcite (30 per cent.)—filling interspaces in the dogtooth quartz.
4. Pyrite (5 per cent.)—coating the country rock under the quartz and also crystallised in the quartz pyrophyllite country.
5. Blende (5 per cent.)—crystals in the dogtooth quartz.

Order of deposition: (i.) Pyrite, (ii.) blende, (iii.) quartz, (iv.) calcite.

Assay (Government Analyst):—

Gold = 1 oz. 6 dwt. 4 gr. per ton.
Silver = 1 oz. 8 dwt. 19 gr. per ton.

Analysis (Government Analyst)—not expected to be available for some months. From the above rough estimation only 3 per cent. zinc is anticipated.

Output—

Crushing.	Yield per ton.	Authority.
50 tons from the lower levels returned 150 oz.	Oz. 3	Carmichael
15 tons run of mine at grass.		
10 tons "seconds" at grass.		
The "firsts" from this lot yielded		"

NEVER NEVER (G.M.L. 117).

Location.—On G.M.L. 117, nearly $\frac{1}{2}$ mile south-south-east from the school-house. The workings are on a gentle rise overlooking Norton Creek.

Workings.—There are two shafts 2 chains apart, both of which are inaccessible. The western or whip shaft was sunk by the Mundio Company about 18 years ago to a depth of 90 ft. It was cleaned out last year and continued 4 ft. by Captain Osborne, but it is now flooded to within 30 ft. of the surface. The eastern shaft is 20 ft. deep. An opencut 12 ft. deep extends for a chain west of the whip shaft.

Reef.—The reef strikes east and west, dipping steeply (80°) to the north (at the surface), but to the south below.

It varies between 4 or 5 in. and 18 in. in thickness, and at the eastern end there is a 2-ft. formation, but "there is no mullock between the mundic and the walls" (Rands).

Ore.—The reef consists of white quartz, carrying, it is said, 50 per cent. sulphides, including copper (1 per cent.), silver and lead, but samples of the ore cannot now be obtained. "The mundic is a coarse iron and arsenical pyrites" (Rands).

The free gold occurred in a shoot not extending beyond the limits of the whip shaft, though mundic was found in the stone in the ends. The ore from the opencut is reported to have carried only $\frac{1}{2}$ oz. gold, while the 2-ft. formation in the eastern shaft yielded 7 dwt. per ton. Nevertheless, it is thought that the ore, after rough handpicking and concentration, might be worth shipping, though "the gold is worth only £2 to £2 10s. per oz." (Rands).

Output—

Claim.	Year.	Crushing.	Yield per ton.	Authority.
P.C. ...	1879	14 tons yielded 32 oz. 6 dwt. (mundic) 3 tons yielded 2 oz. 19 dwt.	Oz. dwt. 2 6 0 19 $\frac{1}{2}$	Carmichael
No. 2 W. ...	1879	11 tons yielded 9 oz. 8 dwt. 8 tons yielded 5 oz. 3 dwt.	0 17 $\frac{1}{2}$ 0 12 $\frac{1}{2}$	"

Partial total, 36 tons for 49 oz. 16 dwt. = 1 oz. 8 dwt. per ton.

NEW CONSTITUTION (OSBORNE'S G.M.L. 103).

Location.—A mile south of the school-house.

A small company was formed in 1904, and erected a crushing plant, with Wilfley table, but soon got into financial difficulties, and abandoned the lease in 1905. The workings are now included in Osborne's G.M.L. 103.

Workings.—The shafts, now inaccessible, were sunk two years ago. The western shaft, 60 ft. deep, is filled with water to within 10 ft. of the surface. At the bottom is a 20-ft. crosscut to the south, with drives both ways on the reef, and above them there are stopes. A cut, 5 chains east of this shaft and 1 chain north of the eastern shaft, is probably on this reef.

The southern shaft, which is 45 ft. (?) deep, is within 20 ft. of the western.

The eastern shaft, which is due south of the school and S. 43° W. from the Frampton, is about 5 chains from the western shaft. Alongside it is an opencut extending 1 $\frac{1}{2}$ chains westwards, and there are trenches and holes for 2 chains eastwards and beyond.

Reef.—The main reef runs E. 16° S. at the western shaft. Its thickness here is 3 ft. 6 in. The distance between the walls of the southern reef, which is parallel to the main reef and distant 20 ft., is said to be 2 ft. The eastern shaft appears to be on a third reef running W. 5° N. to a point 2 chains south of the western shaft. From the granite on the tip, it is presumed that the reef is small.

Ore.—The ore in the main western shaft was solid mundic, which, however, carried payable gold only in the shaft. The ore of the southern reef consists of quartz with 10 per cent. mispickel and 10 per cent. crystallised pyrite.

Output—

Claim.	Crushing.	Yield per ton.	Authority.
Western shaft	{ 30 tons "firsts" crushed for 60 tons	Oz. dwt. 1 9	Carmichael
Southern shaft ...		0 15	"

Partial total, 60 tons for 66 oz. = 1 oz. 2 dwt. per ton.

OLD.

Location.— $\frac{1}{2}$ mile west of the Sulphide, due south of the P.O., and $\frac{1}{4}$ mile E. 16° S. of the Welcome.

Workings.—Old trenches, 20 feet deep.

Reef.—The strike is W. 25° N. and the dip vertical to the north. There is 2 ft. altered granite formation with scorodite stains.

PADDOCK (SMART'S, OSBORNE'S).

Location.—Lies E. 14° S. from the Post Office, and $1\frac{1}{4}$ miles east from the school-house.

The present work was begun by Smart, but the ground is now held as a claim (Osborne and Charley), which is exempt and deserted.

Workings.—The shaft is understood to be 32 ft. deep, but there is a stage at 15 ft., below which no inspection could be made. Besides this, numbers of pot-holes have been sunk, probably on lenticular patches of ore in joints. Operations were begun in the vicinity previous to 1885, but carting was then too expensive for work to be remunerative.

Reef.—The visible lode material in the shaft seems to run south-eastwards, dipping 85° to the north-east. About a foot is ironstained, but only 4 in. can be taken as ore, and even this is reported to have pinched in the drive below.

The country rock is granite, with flat joints dipping north-westwards.

Ore.—The brown stone (granite with quartz veins and iron oxides) is reported to carry 4 to 6 oz. per ton. Quartz, with pyrite, mispickel, and blende, has been raised from the lower portion of the shaft. The "seconds" on the surface consist of altered granite veined with quartz carrying pyrite and mispickel, but very little other mineral, and only a trace of blende.

Output—

Locality.	Crushing.	Yield per ton.	Authority.
Pot-holes E.N.E. of shaft ...	15 tons brownstone	8 or 9 dwt.	Carmichael
Main shaft	? tons	13 dwt.	„

SAILOR BOY (M.L. 98).

Location.—The open cut on Norton Creek, in M.L. 98, is about 4 chains above Chandler's reef— $1\frac{1}{4}$ mile south-south-east of the school.

Workings.—The workings consist of one opencut.

Reef.—The reef strikes W. 12° N., and dips 85° to north. It has been considered the continuation of the All Nations, but on insufficient evidence.

The country rock is a hard undecomposed granite, which on the footwall side is jointed parallel to the reef for 6 ft. from it. At 4 ft. 6 in. from the reef in the hanging-wall is a 6-ft. porphyry dyke.

Ore.—It consists of 3 in. calcite, with approximately 3 per cent. crystallised pyrite and 5 per cent. mispickel, laminated parallel to the walls.

Output—

Year.	Crushing.	Yield per ton.	Authority.
1879	7 tons for 19 oz.	Oz. dwt. 2 14 $\frac{1}{2}$	Carmichael
1881	8 tons for 12 oz. 12 dwt. ...	1 11 $\frac{1}{2}$	„
1883	3 tons for 9 oz.	3 0	„

Partial total, 18 tons for 40 oz. 12 dwt. = 2 oz. 5 dwt. per ton.

SCORPION.

Location.—About 5 chains north-north-east of the Sulphide, and about $1\frac{1}{4}$ mile south-south-east of the school-house.

Workings.—Two shafts and about 2 chains of trenching, now fallen in.

Reef.—Runs N. 40° W.

The country is decomposed granite.

Output—

Year.	Crushing	Yield per ton.	Authority.
1879	15 tons for 23 oz. 3 dwt.	Oz. dwt. 1 10 $\frac{1}{2}$	Carmichael
	20 tons for 14 oz. 10 dwt.	0 14 $\frac{1}{2}$	„
1880	9 tons for 27 oz.	3 0	„
	14 tons for 9 oz. 1 dwt.	0 13	„
	9 tons for 10 oz.	1 2 $\frac{1}{2}$	„
	5 tons for 2 oz.	0 8	„
	6 tons for 5 oz. 3 dwt.	0 17 $\frac{1}{2}$	„
	9 tons for 7 oz.	0 15 $\frac{1}{2}$	„
1881	12 tons for 9 oz. 3 dwt.	0 15 $\frac{1}{2}$	„

Partial total, 99 tons for 107 oz. = 1 oz. 1 dwt. per ton.

SMART'S (SULPHIDE COMPANY).

Location.—About $1\frac{1}{2}$ miles S. 15° E. from the Post Office, and adjacent to Norton Creek on the west. It is now included within the Sulphide Company's claim.

Workings.—The opencut at the south-eastern end is only 1 chain from the creek. Smart's shaft is 2 chains to the north-west of the cut; Smart's second shaft, in which water is standing at 30 ft., is $1\frac{1}{2}$ chains to the north-west of the first; and Smart's third shaft, 22 ft. deep and holding 15 ft. water, is 1 chain to the north-west of the second. (The last shaft is 5 chains E. 15° S. from the eastern shaft on the Sulphide line, with which it is connected by a line of trenches, as described under the "Sulphide.")

Reef.—The strike, according to the shafts, is N. 45° W., and the dip is to the south-west at 75° .

Smart's third shaft is on a big formation, which is less distinguishable in the other shafts. There does not appear to be any defined reef.

Ore.—At Smart's shaft only altered and slightly mineralised granite can be seen. Smart's second shaft was sunk on ironstained decomposed granite, probably originally having pyrite on the joint-planes. The prospectors got good prospects in Smart's third shaft, but a 10-ton trial gave only $\frac{1}{2}$ oz. per ton, and the "ore cut out" into grey granite below. The gold presumably occurred in pyrite on the joint-planes. In the opencut only ironstains on the cracks in decomposed granite can be seen, and it was in these the gold was found.

Remarks.—About 2 chains south-west of the third shaft the granite beside a diorite dyke (2 ft. wide) is ferruginous, and a 10-dwt. crushing is reported from it.

SPOTTED GUM (G.M.L. 104).

Location.—Lies S. 27° E. from Marodian main shaft about 5 chains. The reef was first opened 30 years ago. It is now included within M.L. 104.

Workings.—The shaft is 90 ft. deep (water now at 40 ft.), and the reef has been stoped and trenched for 40 ft. to north-west and for $1\frac{1}{2}$ chains to south-east.

Reef.—The strike is N. 50° W., vertical.

The reef is reported to be 9 to 12 in. wide; and 4 in. have been left standing at one place on the surface.

A small branch vein on the north has been opened east of the shaft.

Ore.—The ore is quartz in which the fissure is central.

Output—

Year.			Crushing.	Yield per ton	Authority.
				Oz. dwt.	
1879	...	...	15 tons for 23 oz.	1 10 $\frac{3}{4}$	Carmichael
			14 $\frac{1}{2}$ tons for 15 oz.	1 0 $\frac{3}{4}$	
1880	...	...	2 tons for 3 oz. 12 dwt.	1 16	"
1881	...	...	16 tons for 16 oz. 7 dwt.	1 0 $\frac{1}{2}$	"

Partial total, 47 $\frac{1}{2}$ tons for 57 oz. 19 dwt. = 1 oz. 4 dwt. per ton.

SULPHIDE.

Location.—The main shaft is 5 chains west of Norton Creek, about $\frac{1}{4}$ mile north of Iv, Milton, and 1 $\frac{1}{2}$ miles S. 15° E. from the Post Office.

The claim has been idle (under exemption) since the end of 1905, for want of capital, and is now apparently abandoned.

Workings.—McDonnell's shaft, 47 ft. deep, was begun two years ago; from the bottom a drive runs 30 ft. south. Halfway along it a winze was sunk 42 ft., and from the bottom of the winze drives have been opened 40 ft. north-west and south-east. Owing to the foul air at 25 ft. below the surface, it was impossible to inspect these workings, but it is understood that some stoping has been done above the 47-ft. level.

The eastern shaft, 20 ft. deep, is 2 $\frac{1}{2}$ chains south-east of McDonnell's.

Within 2 chains south-west of McDonnell's shaft there are four parallel trenches.

A line of trenches, 10 ft. deep, $\frac{1}{2}$ chain long, and $\frac{1}{2}$ chain apart, connect the eastern shaft and Smart's third shaft, elsewhere referred to.

Reef.—The Sulphide lode runs N. 45° W., dipping 1 in 6 to the north-east at the shaft bottom, but almost vertical in the winze.

The reef is 4 ft. wide in the stopes south of the main shaft, but on the 47-ft. level at 29 ft. south of the shaft it pinched to 3 in. The south-eastern drive on the 89-ft. level for 15 ft. followed a $\frac{1}{4}$ -in. leader, then, opening out to 8 in. of black sulphides (sent to Cockle Creek), with 18 in. "spar" between the lode and the footwall.

The reef in the eastern shaft was 15 in. wide at the surface.

Ore.—The ore is an altered granite, in which granular white quartz, pyrophyllite and sericite (?) can be distinguished. It contains veins of quartz and mispickel (say 20 per cent.), rendering the rock in some places a perfect stockwork, while in others the granite has been

wholly replaced. The blende in parts amounts to 5 per cent. That the gold occurs chiefly in the sulphides has been proved by crushings, yielding only 14 dwt. per ton, while the concentrates contained 4 oz. The coarsely crystallised mundic has been found to be comparatively poor—15 dwt. gold per ton.

In my sample (98) from the 7 tons of "seconds" at grass (from which probably an equal amount of mullock had been removed), the ore—replaced shattered granite—consists of:—

1. Quartz and pyrophyllite (75 per cent.)—quartz original and secondary with pyrite.
2. Mispickel (10 per cent.)—disseminated in quartz.
3. Pyrite (10 per cent.)—crystallised in quartz, much leached.
4. Blende (5 per cent.)—bunches among pyrite masses and also filling interspaces in quartz.
5. Chalcopyrite (trace)—filling interspaces in quartz and blende.

Order of deposition: (i.) Mispickel, (ii.) pyrite, (iii.) quartz, (iv.) blende, (v.) chalcopyrite.

Assay (Government Analyst):—

Gold = 1 oz. 8 dwt. per ton.
Silver = 2 oz. 7 dwt. 4 gr. per ton.

Analysis (Government Analyst)—not expected to be available for some months. Only 3 per cent. zinc is shown in the above rough estimation.

Output—

Claim.	Crushing.	Yield per ton.	Authority.
Main shaft ...	10 tons yielded 2½ tons concentrates* Samples of the concentrates have yielded gold and silver	3 oz. 5 dwt. to 4 oz. 5 dwt. 15 oz.	McDonnell
	3 tons yielded 16 cwt. concentrates and 3 oz. 8 dwt. gold	1 oz. 2 dwt.	"
	3 tons brownstone puddocked are expected to yield	14 dwt.	Carmichael
Eastern shaft	6 tons brownstone yielded	12 dwt.	"

* These concentrates have been sent to Cockle Creek, but the returns are not yet available to me.

Remarks.—The trenches south of the main Sulphide shaft are on bunches of ore ("formation" or "stone reef"), all of which were rich in scorodite. The work done indicates very short rich shoots at frequent intervals. One trench, 2 chains south of the shaft, runs E. 30° S. The reef can be seen in another trench 15 ft. south of this to be 6 in. wide. A big porphyritic dyke, 2 chains north of the Sulphide shaft, runs E. 15° N.

WELCOME.

Location.— $1\frac{1}{2}$ mile south of the school-house. McDonnell's is the only claim now held on this line.

Workings.—These comprise old trenches and pot-holes at the eastern end, and several shafts about 20 ft. deep. McDonnell's shaft, 23 ft. deep, having been just cleaned out, was inspected. About 5 chains to the west of McDonnell's are two or three very old pot-holes on the same line.

Reef.—The strike is east and west and the dip is south about 80° . At the eastern end only 9 in. "formation" is visible, but there is some quartz at the western end.

Ore.—Very little ore of any kind can be seen on the surface, or in McDonnell's shaft either, though the claimholders stated that they were re-opening the shaft because they had found some mundic in stone from it.

Output—

Year.	Crushing.	Yield per ton.	Authority.
		Dwt.	
1879	14 tons for 8 oz. 8 dwt.	12	Carmichael
	$3\frac{1}{2}$ tons for 2 oz. 10 dwt.	$14\frac{1}{2}$	"
1880	25 tons for 8 oz. 8 dwt.	62	"
	$24\frac{1}{2}$ tons for 14 oz. 10 dwt.	$11\frac{1}{2}$	"

Partial total, 67 tons for 33 oz. 16 dwt. = 10 dwt. per ton.

WHO'D-HA'-THOUGHT-IT (G.M.L. 104).

Location.—In the north-eastern part of G.M.L. 104, of 40 acres, about 4 chains south-east of the Post Office. The workings are among the oldest on the field, and the plant includes a 14-h.p. winding engine. The lease was under three months' exemption from the beginning of December, 1905.

Workings.—The main Marodian shaft, 320 ft. deep, lies S. 31° W. four chains from the north-eastern corner of the lease. The shaft was cleaned out to 200 ft. depth by the Marodian Company, but since they ceased operations it has filled with water to within 40 ft. of the surface.

The western shaft is $1\frac{1}{2}$ chains to the west of the main shaft, and an opencut extends for two chains to the east of the same.

Reef.—The reef runs E. 12° N., and is vertical.

Its thickness is only from 1 to 3 in.; it is therefore generally referred to as the Who'd-ha'-Thought-It leader, and mining costs have always been excessive.

Between the 200 and 290-ft. levels the leader lay in contact with the Marodian reef, and at the latter level pinched out altogether. It was also lost on the surface about 2 chains east of the main shaft.

"The shoots of ore have a westerly direction" (Rands).

The country is granite. At 200 ft. below the surface a dyke (decomposed, and pyritous near the reef) runs down to the reef, and follows it to the shaft bottom.

Ore.—Of the ore at the brace one-half is calcite, the remainder being quartz and crystallised pyrite, blende, and galena. It has been very rich in gold, carrying, it is said, 3 oz., with 12 oz. silver, per ton. Mr. Rands stated that it "averaged 8 to 10 oz. per ton, and in parts has gone as much as 20 oz. per ton." The value of the gold is £3 per oz.

In my sample (101) from the 200-ft. level, at grass, the ore, with quartz pyrophyllite country, consists of:—

1. Calcite (50 per cent.)—bluish and brownish veins and also filling interspaces of dogtooth quartz.
2. Quartz (20 per cent.)—glassy veins.
3. Pyrite (15 per cent.)—crystals in quartz and in silicified country, also some later than the quartz, as rounded crystals and grains.
4. Blende (10 per cent.)—crystals in quartz, in calcite (scarce) and in pyrite.
5. Galena (5 per cent.)—massive between quartz layers and country, and also in pyrite interspaces.
6. Mispickel(?) (traces)—fine-grained mineral in a cross crack.

Order of deposition: (i.) blende, (ii.) pyrite, (iii.) galena, (iv.) quartz, (v.) calcite, (vi.) mispickel (?).

Assay (Government Analyst):—

Gold = 5 oz. 10 dwt. 9 gr. per ton.

Silver = 6 oz. 9 dwt. 14 gr. per ton.

Analysis (Government Analyst)—not expected to be available for some months. The above rough estimation shows the presence of zinc = $6\frac{1}{2}$ per cent. and lead = 4 per cent.

Output—

Claim.	Year.	Crushing.	Material.	Yield per ton.	Authority.
Hickey's ...	1879	11 tons for 308 oz. ...	...	Oz. dwt. 28 0	Carmichael
	1879	9 tons for 12 oz. ...	...	1 6 $\frac{3}{4}$	"
	1880	4 tons for 6 oz. 19 dwt. ...	...	1 14 $\frac{1}{2}$	"
	1880	7 $\frac{3}{4}$ tons for 167 oz. 11 dwt. ...	...	21 12 $\frac{1}{2}$	"
		Crushings yielding ...	...	25 0	Warden
		10 $\frac{1}{2}$ tons for 32 oz. 10 dwt. ...	Screenings ...	3 2	Carmichael
		3 $\frac{1}{8}$ tons for 17 oz. 4 dwt. ...	Tailings ...	4 4 $\frac{1}{2}$	"
	1881	6 tons for 26 oz. 12 dwt. ...	...	4 8 $\frac{1}{2}$	"
	1882	9 tons for 90 oz. 10 dwt. ...	...	10 1	"
		7 tons for 140 oz. ...	...	20 0	"
Main shaft, 300 ft.	...	50 tons for 150 oz. ...	...	3 0	"
		$\frac{1}{2}$ ton for 18 oz. 15 dwt. ...	From tip ...	37 10	"
		2 $\frac{1}{2}$ tons for 8 oz. ...	Tailings ...	3 4	"
		9 tons for 68 oz. 10 dwt. ...	...	7 12 $\frac{1}{2}$	"
	1885	16 $\frac{3}{4}$ tons for 48 oz. 19 dwt. ...	...	3 0	Rands
	1886	6 tons for 47 oz. ...	...	7 16 $\frac{3}{4}$	Carmichael
	1894	4 tons for 38 oz. 10 dwt. ...	Headings ...	9 2 $\frac{1}{2}$	Warden
	1902	5 $\frac{1}{2}$ tons for 6 oz. 10 dwt. ...	...	1 3 $\frac{1}{2}$	"
	1903	77 tons for 223 oz. ...	Oxidised, 1 $\frac{1}{2}$ oz. Sulphide, 3 oz. }	2 18	"
	1905	50 tons at grass ...	...	...	Manager
		10 tons returned 6 $\frac{1}{2}$ oz. gold	...	0 12 $\frac{1}{2}$	
		$\frac{1}{2}$ ton 3 oz. ...	Concentrates ...	1 $\frac{1}{2}$	
			Tailings ...	0 19	
				3 1 $\frac{1}{2}$	

Partial total, 249 tons for 1,440 oz. 5 dwt. = 5 oz. 16 dwt. per ton.

OUTPUT.

The returns as given below, and in the descriptions of the various reefs, must be acknowledged to be fragmentary. The total annual yields have been compiled chiefly from the Warden's annual reports, which, unfortunately, have been published only since 1878, whereas gold was discovered here seven years previously. Most of the yields of individual reefs were obtained from Mr. Carmichael, of Norton, whose records, however, are incomplete, while his crushings began only in 1879, in which year he erected his battery on the field. A few of the early returns are given in Mr. Rand's report, and some of the latest have been sent me by Captain Osborne.

OUTPUT OF NORTON FIELD, 1878 TO 1905.

Year.	Material.	Amount.	Treatment.	Total yield.	Yield per ton.	Value per oz.	Authority.
		Tons.		Oz. dwt.	Oz dwt. gr	£ s. d.	
1878	...	222	Crushed ...	956 16 =	4 6 0	...	Warden
1879 } 1880 }	...	1,849	...	3,662 10 =	1 19½ 0	...	"
1881	...	200	...	301 0 =	1 10 0	...	Carmichl
1882	...	285	...	876 0 =	3 1½ 0	...	"
1883	...	11	...	15 0 =	1 7 0	...	"
1871 to 1884	...	2,766	...	7,883 0 =	2 17 0	...	Rands
1886	...	70	Chlorinated	210 0 =	3 0 0	...	Warden
1887	...	1,000	"	2,553 5 =	2 11 0	4 3 0	"
1888	...	?	"	3,702 0	...	4 3 6	"
...	...	8	"	29 0 =	3 12½ 0	...	"
1889	...	1,775	"	?	...	...	"
1891	...	617½	Crushed	186 0 =	0 2 5	...	"
1892	...	695½	"	240 13½ =	0 7½ 0	...	"
1893	...	695½	"	132 3 =	0 4 0	3 0 0	"
1894	Headings	4	"	36 10 =	9 2 0	...	"
...	Surface	1,353	"	180 14 =	0 2 16	3 0 0	"
1895	...	708	"	78 6 =	0 2 3	3 0 0	"
1896	...	46	"	21 18 =	0 12 12	3 0 0	"
...	Concentra's	22	...	20 5 =	0 18 9	...	"
1900 and previous years	Tailings and headings from shafts	3,046	...	613 11½ =	0 4 3	...	"
...	...	80	...	45 0 =	0 11 6	...	"
1902	...	23½	...	40 0 =	1 14 0	...	"
1903	...	77	...	223 0 =	2 18 0	...	"
1904	...	145	Crushed	65 4½ =	0 9 0	...	"
...	Concentra's	132½	"	329 7½ =	2 10 0	...	"
1905	...	93½	"	79 15½ =	0 17 0	...	"
1905	...	79½	Treated ...	143 3½ =	1 16 0	...	"
...	Concentra's	1½	...	4 2 =	2 7 0	...	"
Partial total	...	12,814	..	16,630 18½ =	1 6 0	...	

TREATMENT.

The aim at Norton has hitherto been to save only gold and silver, but should the ore available be proved sufficient in quantity to warrant the expenditure on plant, any combinations of the processes offered below might be worthy of consideration, in order that the zinc, lead, and copper might also be saved.

The demand for zinc is not likely to show any falling off, and as the mines of Joplin, Missouri (one of the world's largest producers), are showing signs of depletion, the price is not expected to fall. Large supplies are now being secured in the western United States, these having hitherto been neglected owing to their complex character, while the poorer eastern ores were available. The consequence is, that methods of treatment are being devised, and electro-magnetic separation is receiving a thorough trial.

SMELTING.

Owing to the difficulties and consequent high cost of smelting, impurities in zinc ores are especially objectionable, and zinc in excess.

Plate IV.



CARMICHAEL'S BATTERY AND WATER-JACKET SMELTER, NORTON, [L. C. B., photo.]

of 2 per cent. is looked upon with considerable disfavour by the copper and lead smelter, though some metallurgists affirm that up to 10 per cent. of zinc can be successfully slagged off.

Bartlett Process.

Nevertheless, a special process has been used at the Bartlett Works, Colorado,* which is an extreme case of pyritic smelting, two rows of tuyeres being in use in the blast furnace to cause rapid oxidation and volatilisation of the lead and zinc, and the formation of gold and silver bearing copper matte. It is specially applicable to ores containing a mixture of lead and zinc (especially over 20 per cent. of the latter), with but little copper. The only disadvantage appears to be the high loss of silver (6 to 15 per cent.) in the lead-zinc fumes, which are condensed to form pigment. Fuel costs may, however, be considerable.

Water-jacket Blast Furnace at Norton.

Mr. Carmichael some months ago erected a water-jacket blast furnace adjacent to his battery, with the intention of smelting the Norton ores, but he found it impossible to economically put the charges through it, owing to the presence of zinc in the ore. The internal section at the tuyeres is 3 ft. 10 in. by 1 ft. 6 in., and the capacity of the smelter is 30 tons a day. The castings were made in Burns and Twigg's Rockhampton foundry, and the total cost of the furnace, with Gunter blower, was £700.

For the purpose of testing the various ores brought to him, Mr. Carmichael designed an experimental furnace, which is worth describing. A 6-gallon oil drum forms the outer wall of the furnace, and a Galloway boiler tube, inside it, the inner wall, a current of water passing in the space between the two. A pipe at the base of the Galloway tube is used for the blast, and a spout conducts the molten material out at the opposite side.

WASHING.

It is important generally to separate the sulphides prior to smelting, and the cheapest way, when it is possible, is by washing after crushing. By the use of the jig (as at Joplin), vanner, shaking table, or percussion table, there should be no difficulty in separating the galena (specific gravity = 7.5), from the pyrite (sp. gr. = 5), blende (sp. gr. = 4), and chalcopyrite (sp. gr. = 4.2), and at the same time getting rid of the calcite (sp. gr. = 2.7) and quartz (sp. gr. = 2.6). The galena might then go direct to the smelter, but the pyrite-blende-chalcopyrite "middlings" would require further treatment by magnetic separator.

* "Matte Smelting." H. Lang.

Battery Treatment and Concentration at Norton.

At the present time there are two stamper batteries at Norton—Carmichael's ten-head (of which five are out of commission), and Todman's three-head. Carmichael is now making a very clean separation of the sulphides from gangue on a percussion table of extremely elementary design. The table is built of eight flooring boards, 8 ft. in length with four equidistant crossboards as stays. The ram, 3 in. by 2 in., and 6 in. long, is let into another flooring board attached to the cross stays. This is pressed against an ordinary buggy spring by a 5-in. cam, revolving at such a rate that the table receives two throws per second. The surface of the table is furnished with undercut riffles $\frac{1}{4}$ -in. high, $\frac{3}{4}$ -in. wide, and 1 in. apart; and the cant of the whole surface is 2 in. from back to front, and $\frac{1}{2}$ -in. from feed end to discharge end. The table is swung from overhead beams by $\frac{1}{2}$ -in. rods, fitted at the upper ends with regulating nuts. The total cost of timber and nails required is only 15s., and the machine can be fitted up by any carpenter and mechanic.

MAGNETIC SEPARATION.

Magnetic separation is employed generally for minerals of like specific gravity—*e.g.*, blende, pyrite, chalcopyrite, &c.—from which the relatively lighter or heavier minerals may have been previously removed on jigs, vanners, or tables. Artificial magnetism is sometimes produced in sulphides and oxides by a rapid roast.

Magnetic separators have been classed* as follows:—

- I. Ore on conveying belts passing the magnetic field; Conkling, Wetherill,† (1½ to 30 tons per hour), Chase, Hoffman, Kessler, Rowland (2 tons per hour), Ball-Norton, Heath, Odling,‡ Heberli wet, Edison fine, &c.
- II. Ore falling on a rotating cylindrical drum, within which are magnets: Ball-Norton, Monarch (1½ tons per hour), Heberli, Ferraris, Siemens and Halske (1 to 1½ tons per hour); Wenstrom (5 tons per hour); Buchanan (6 tons per hour); Sautter (4 to 5 tons an hour); Siemens (1 ton per hour); Payne, Imperial, Langguth, &c.
- III. Ore falling vertically past magnets: Edison (16 tons per hour); Heberli, Dellvick-Gröndal,§ Rowland (2 tons per hour); Hedburg, Mechenich,|| Snyder,¶ Ullrich** (2 tons per hour).
- IV. Ore separated by repulsion and use of static electricity: Blake-Morscher†† (½-ton per hour); Pickard (Wynne).

* See "Ore Dressing." By Robert H. Rickards.

† Coming into use in the Silesian zinc mills.

‡ Designed at the Pinnacles Mine, Broken Hill, N.S.W.

§ Used for Swedish iron ores.

|| Successfully operated in Silesian mills, and at the Central Mine, Broken Hill.

¶ Used at Leadville, Colo., U.S.A.

** Used at the Australian Metal Works, Broken Hill.

†† Used in Wisconsin, U.S.A.

It is held that the third class should theoretically give the most economical results, but that this is not altogether sustained in practice is proved by the successful operation of machines belonging to the other classes. There are now, in fact, so many types that it would be unwise to make a selection of any without first having thoroughly investigated the claims and performances of all the different types in use. One, for instance, that has been designed for the separation of a highly magnetic mineral from a non-magnetic should not be expected to give satisfaction in the separation of minerals of similar magnetic attractability.

Treatment at Leadville, Colorado.

The Leadville ore has the following composition:—*

Zn = 24%; Fe = 25%; Pb = 6%; SiO₂ = 4%; and Ag = 8 oz. per ton.

It is first passed over Wilfley tables, and then through magnetic concentrators, and these are the results:—

The Wilfley concentrates, worth £2 per ton, and amounting to 36 per cent., contain—

Zn = 38%; Fe = 17%; Pb = 2.5%; SiO₂ = 4%; and Ag = 4 oz. per ton.

The Wilfley middlings, worth £1 13s. per ton, and amounting to 38 per cent., contain—

Zn = 11%; Fe = 28%; Pb = 16%; SiO₂ = 3%; and Ag = 9 oz. per ton.

The magnetic separator concentrates, worth £3 12s. per ton, and amounting to 29 per cent., contain—

Zn = 50%; Fe = 7%; Pb = 1%; SiO₂ = 6%; and Ag = 3½ oz. per ton; value, £3 12s. p. ton

The magnetic separator middlings (49 per cent.), worth £1 10s. per ton, contain—

Zn = 8%; Fe = 35%; Pb = 9%; SiO₂ = 2%; and Ag = 11 oz. per ton.

Treatment in Virginia.

At a mine in Virginia† the ore is jigged, and the concentrates containing—

Zn = 7%; Fe = 5%; Pb = 65%—

are sent to the smelter, while the middlings go to the magnetic separator, which produces zinc concentrates containing—

Zn = 44%; Fe = 5%; Pb = 1.5%

OIL CONCENTRATION.

In the Elmore process the finely ground ore is agitated in special vessels, with a layer of oil. Certain sulphides, being wetted and adhered to by the oil, will be collected in it, and may thus be separated from some others, and most of the gangue minerals. For instance, it is possible to separate gold, silver, copper pyrite, grey ore, stibnite, galena, &c., from blende, &c.

* W. R. Ingalls, "Engineering and Mining Journal," 19th August, 1905.

† E. Higgins, "Engineering and Mining Journal," 30th March, 1905, and 6th April, 1905.

LEACHING.

Danziger's process was designed for low-grade ores containing pyrite and blende. The ore is roasted to form ferrous sulphate, which is leached out, leaving the blende more or less free from iron, and in a better condition for smelting.

CHLORINATION.

Former Treatment at Norton.

Chlorination has in the past been successfully carried out at Norton, the Frampton United Company having in 1886 erected a barrel chlorination plant and five reverberatory furnaces, of a capacity of 60 tons a week, at a cost of £3,000. The furnaces were kept supplied by ten head of stampers, a dry crusher, installed at a cost of £800 in 1888, proving a failure. These chlorination works were suddenly shut down in 1891, for reasons of which there are no records, but possibly because of a change in the composition of the ore mined, such as an increase in the amount of zinc, copper, and lime, all of which, as oxides, absorb chlorine, and may prevent the application of the process. The copper might, however, be leached out after the roast, and the lime, if present in relatively small amounts, could be first neutralised by acid.

A roasting and chlorination plant was erected here in 1889 by the Advance Company, but work at it was abandoned in the following year, after an unsuccessful attempt to treat 70 tons of ore. The non-success of the process in this case was in all probability due to the large amount of calcite in the ore.

Still another attempt was made at chlorination by Mr. Carmichael in 1895, but it would appear, like the others, to have failed.

Treatment at Cassilis, Victoria.

An example of the successful application of the process to a somewhat similar ore is to be found at Cassilis,* in Victoria, where the ore contained 10 oz. per ton at the surface, but suffered a rapid fall in value in the refractory sulphides (nispickel, pyrite, blende, and 7 per cent. galena, with siderite, and less than 1 per cent. each of antimony, manganese, copper, and tin). The proposition here was to save only gold, silver, and lead, and, therefore, though experiments in magnetic separation were carried out, the method in use consists in the separation of galena and copper ore on Wilfley tables after hydraulic classification. The galena concentrates are then shipped to smelters, the pyritic concentrates (15 to 20 per cent.) are chlorinated after roasting,

* "Engineering and Mining Journal," 29th July, 1905.

and the tailings are cyanided. The following items of cost are interesting:—

	£	s.	d.	
Mining development and transport	0	15	8	per ton crushed
Milling	0	4	10	„ „
Roasting (Edwards's Mechanical Furnace) ...	0	10	5	„ „
Chlorination	0	9	3	„ „
Cyaniding	0	3	0	„ „
Shipment and smelting	0	1	9	„ „
	£2	4	11	„ „

FUTURE PROSPECTS.

The future of the goldfield depends, firstly, on proving or indicating the existence of ore in some quantity in the ground; and, secondly, on the selection of a suitable method of concentrating the ores.

With regard to the former, 28 lines of reef have been described above. They are generally less than 12 in. in thickness, but in exceptional cases reach 3 ft., and even more. Unfortunately, only a few of the reefs could be examined in the working places by me, owing to the general suspension of operations on the field. Much of the information given is chiefly hearsay, on which, of course, implicit reliance cannot be placed.

Mr. Rands, in his 1885 report states, after inspecting the then working mines, that “auriferous pyrites ores undoubtedly exist here in large quantities.”

The Norton reefs have hitherto been worked almost solely for their gold and silver contents, and the returns would, but for the complex sulphides in the ore, have returned a profit. I am of opinion that if a method of treating these sulphides were brought forward, and a plant put into operation on the field for the saving of all the metallic values, many reefs, hitherto neglected because of their poverty in gold, would be opened up. I further consider that the reefs discovered at Norton amount to only a fraction of those on intervening joint planes overlooked in prospecting owing to their low gold and silver contents.

Brisbane, 17th May, 1906.

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Queensland.

DEPARTMENT OF MINES.

Geological Survey of Queensland.

PUBLICATION No. 209.

SOME GOLDFIELDS

OF THE

CAPE YORK PENINSULA.

BY

WALTER E. CAMERON, B.A. (Cantab.),

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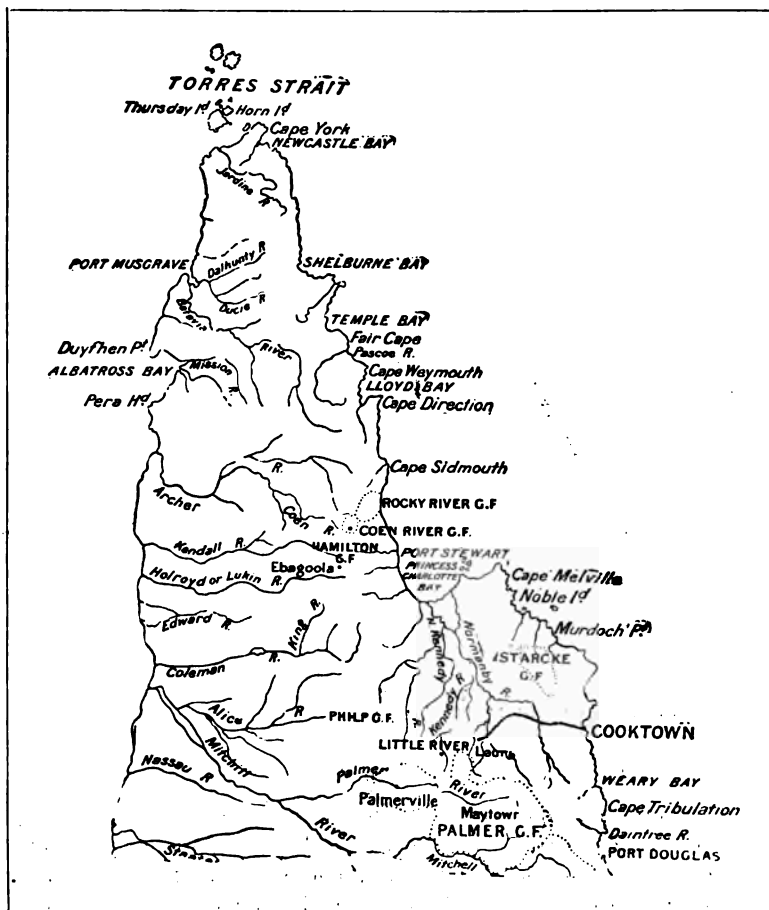


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SOME GOLDFIELDS OF THE CAPE YORK PENINSULA.

I.—THE STARCKE GOLDFIELD.

The Starcke Goldfield occupies an area of about 60 square miles, between the Normanby River and the east coast, about 40 miles north-north-west of Cooktown. Gold was first found in this district in 1890, at the end of which year 230 men were working alluvial along the



LOCALITY SKETCH SHOWING POSITIONS OF THE CAPE YORK GOLDFIELDS.

Scale about 110 miles to the inch.

gullies at the head of a river supposed to be the Starcke. The Starcke River proper, however, was discovered and named by Dr. Jack in his trip from Cooktown to the Coen River in 1879, and lies about ten miles further to the west, entering the sea to the north-west of Murdoch Point, in which position it is mapped on all the colony maps as yet issued.

During the six years, 1890 to 1895, some 2,351 oz. of gold, worth about £4 per oz., are recorded as having been obtained from the gullies forming the head of the eastern branch of the river above referred to. This locality is now known as the Old Starcke, and has been abandoned since 1895. Attempts were made to prospect several veins by sinking shafts and by tunnelling to meet them at greater depths, but in no case were any payable reefs discovered.

In 1892, gold in association with antimony and quartz was found on Cocoa Creek, a tributary of the McIvor River, and was worked successfully for about five years, returning in that time 1,108 oz. of gold bullion, reported as worth £3 18s. per oz., the greater portion coming from the ore vein found in a claim known as the First Call. The workings have been idle since 1896, but the ground has been recently taken up by an English syndicate, who propose continuing the work with a view to recovering the antimony as well as the gold.

In 1896, alluvial gold was discovered at a locality five miles further down the river from the Old Starcke Camp, and about eight miles by road from the mouth. This locality is now known as Munburra. During the three years, 1896-1898, 1,479 oz. of alluvial gold are reported to have been obtained here, and the alluvial appears then to have become worked out. In the latter year, however, reefs were located and reward claims granted on the Last Hit and Monte Carlo reefs, and a two-head stamper battery was erected. A second small battery was introduced in the following year, and from then till the end of last year the field had returned some 7,666 oz. of gold from 3,293 tons of stone.

At the time of my visit in May last, work was being carried on at only three of the smaller reefs, trouble with water having necessitated the abandonment of the majority of the shafts pending the introduction of pumping machinery to cope with it.

COCOA CREEK GOLD AND ANTIMONY REEFS.

The only reef that has been mined to any extent in this locality is in the First Call Mine. The country rock is composed of slates and sandstone, striking north and south, and standing nearly vertical. The lode runs east and west in slates, and is almost vertical, underlying slightly to the south. The shoot of ore, composed of quartz carrying a large quantity of stibnite (antimony sulphide), is about 120

ft. in length, and is reported by the owners to have been worked down to a depth of about 150 ft. by means of two shafts sunk from the outcrop, about 100 ft. apart. These shafts are connected by a level at the bottom, and all the pay ore, except a width of about 15 ft. above the 150-ft. level, has been mined and crushed. The lode in the bottom is said to average about 1 ft. 6 in. in thickness; but, as the shafts had been in disuse since 1897, the mine could not be inspected. On its eastern end the shoot of good ore breaks up on the surface into a number of small leaders of quartz as it passes into a belt of sandstone. Several of these have been prospected by shallow holes, but without much success.

The following are the returns, as given in the Annual Reports of the Department of Mines, of stone crushed and gold obtained from the Cocoa Creek reefs during the five years that they were working. Most of this stone came from the First Call Mine, though several small lots were from other reefs in the neighbourhood:—

RETURNS FROM COCOA CREEK REEFS.

					Stone Crushed.	Gold Returned.
					Tons.	Oz.
1892	...	...	...	...	16	41
1893	...	...	...	...	367	352
1894	...	...	...	...	561	539
1895	...	...	...	...	174	138
1896	...	...	...	...	21	38
					1,139	1,108

As the value of the gold is recorded as averaging about £3 18s. per oz., this gives a total value for the 150 ft. of sinking of about £4,321, and an average value for the stone of about £3 16s. per ton. This takes no account of the amount of gold lost in the tailings, which, on account of the nature of the ore and the crude dressing appliances used, was probably considerable; nor of the value of the antimony, of the percentage of which there is no record.

THE MUNBURRA REEFS.

The reefs in the neighbourhood of Munburra occur in altered sedimentary rocks, made up of slates, quartz-schists, and quartzites, with a general meridional strike and very steep dips to east or west. The greater number lie close to two parallel dykes of porphyry, which also have a north and south strike. The western dyke, which is the more prominent of the two, can be traced from Munburra Creek, near the township, to the seaward slope of the coast range, about three miles further north. The second dyke lies about a mile further to the east. The reefs strike for the most part at right angles to these dykes, and to the strike of the slates and schists, though a few, on the other hand, appear to conform to the bedding of the slates and schists.

The following table gives the annual return of reef gold from the Munburra reefs from 1898 to 1905:—

RETURNS FROM MUNBURRA REEFS.

					Stone Crushed.		Gold Returned.	
					Tons cwt.		Oz. dwt.	
1898	...	...	...	...	76	0	990	0
1899	...	...	...	...	1,222	0	2,644	0
1900	...	...	...	...	667	0	907	0
1901	...	...	...	...	283	0	1,070	0
1902	...	...	...	...	528	0	1,267	10
1903	...	...	...	...	278	5	501	0
1904	...	...	...	...	181	10	273	0
1905	...	...	...	...	58	0	74	1
					3,293	15	7,666	11

The rapid falling off in returns since 1902 is accounted for by the fact that, notwithstanding the rich value of the stone crushed from above the water-level, averaging some £9 5s. per ton, no reserves were formed for the purpose of coping with the water when it was met with, and of carrying on economical mining under the more arduous conditions involved in increasing depths.

The Boomerang Reef.

The Boomerang reef lies on the eastern side of the western dyke of porphyry referred to above, about half a mile north of Munburra. The P.C. shaft is situated about 40 ft. from the wall of the dyke, and has been sunk to a depth of about 80 ft. The reef was driven on at the water-level (55 ft. down) to north and south, and the ore stoped out to the surface over a length of about 60 ft.

According to the mill returns, 166 tons of stone were crushed from this shaft during the years 1898 to 1904 for a return of 839 oz. 1 dwt. of gold. The value of the gold is given as about £3 17s. per oz., which would give a total value of £3,230, and an average value of the stone of over £19 per ton.*

The last crushings were taken out by a company called the Queen Alexandra Company, working during the years 1902-1904, when they sank the shaft from the 35-ft. level to the bottom, and raised 118† tons of stone, which returned them 342 oz. 8 dwt. of gold.

From the amount of stone crushed from this shaft, it may be inferred that the reef averaged about 1 ft. in thickness. The shaft is 7 ft. by 4 ft. 6 in., timbered, and in good order to the 55-ft. level. The Queen Alexandra Company installed an 8-h.p. vertical boiler and pump, with a 2-inch outlet pipe, but were not able to cope with the water, and the enterprise was given up. It was impossible to get down the shaft and examine the sink without unwatering it.

* Inadvertently printed as £9 in "Mining Journal," December, 1906.

† Inadvertently given as 166 tons in "Mining Journal," December, 1906.

About 200 ft. east of the P.C. shaft, and a little to the north of the line, several shafts have been sunk on a parallel reef to depths of about 60 ft., and over a length of about 100 ft. From these shafts, situated on the No. 1 and No. 2 East Boomerang claims, 241 tons of stone appear to have been raised, for a return of about 1,177 oz., of a value of £4,532 15s. This gives an average value for the stone crushed of over £18 per ton, and, notwithstanding the apparently small size of the reef (judging from the small amount of stone raised) the high quality of this stone should make this reef worth further development.

According to the Warden's records, the total amount of stone from the Boomerang reefs was 529 tons 3 cwt., returning 2,393 oz. 12 dwt. 14 gr. of gold, of a value of about £9,214, thus giving an average value for the stone of over £17 per ton.

Last Hit Reef.

On the Last Hit reef, a shoot of ore, apparently about 150 ft. in length, was worked down to the water-level (about 50 ft.) by three shafts in the P.C. and No. 1 West claims. The water was met at this depth, and proved too much to allow of further sinking without installing pumps or steam winding gear. The workings to the east were bounded by a fault, beyond which a white barren reef is reported to have been picked up and driven on for 30 ft. To the west of the No. 1 West shaft the reef is reported to have split up into several leaders.

About 250 ft. east of these workings, and about 40 ft. up the rise of the hill, a second shaft was sunk, near the eastern boundary of the P.C. claim, to a depth of 95 ft.; and a shoot of stone, about 40 ft. long, was worked out down to that depth. This shoot is reported to have split up, going west into several leaders; and to have cut out against several leaders (carrying rich gold near the junction) on the eastern end. The total crushings from the P.C. and No. 1 West claims amount to 1,223 tons for 2,930 oz., worth about £11,729. From the work done, this indicates a reef averaging 1 ft. 6 in. throughout, and worth over £9 per ton. It is impossible to say what the ore below the water-level is worth, as the shafts could not be descended. A sample of mundic ore, taken from a small heap on the surface lying near the middle shaft of the P.C. claim, and said to have come from the 50-ft. level, gave a return of 1 oz. 12 dwt. of gold and 5 dwt. of silver, representing a value of over £6 per ton. This sample, though not up to the average of the returns from the brown stone, should, if it occurs for the whole length of the shoot of 150 ft., be well worth further development.

The Gladstone Reef.

About four miles north of Munburra, on the road to the landing at the mouth of the river, is the Gladstone Mine. Here a tunnel, going west into the side of a hill about 60 ft. below the crown, met the

eastern end of a shoot of stone about 40 ft. in length, which had been worked down from the cap of the ridge. The reef cuts across north and south, striking micaceous schist and sandstone, with a dyke of porphyry following the bedding in the middle of the shoot of stone. A winze has been sunk 70 ft. below the tunnel level, and a drive put in 40 ft. west from the bottom.

A second winze was then put down on the ore to a further depth of 50 ft. The stone has been stoped out on the west side of this winze for about 12 ft. in, and still shows a seam of 4 in. of quartz on the hanging-wall, with about 3 ft. of greywacke interspersed with quartz veins on the footwall. A sample from this face gave only 1 dwt. 9 gr. gold per ton and 1 dwt. 19 gr. silver per ton. About 250 tons of stone have been crushed from this mine, for a return of 376 oz. 1 dwt. of gold.

Besides these three main reefs, a number of smaller lines, most of them connected with the eastern dyke of porphyry, have returned varying quantities of gold. None of these, however, have been very prolific, and, as little or no work was being done on them, it was difficult to get any accurate information concerning them.

II.—THE ALICE RIVER (PHILP) GOLDFIELD.

This field lies about 80 miles a few points north of west from Laura, the terminus of the Cooktown Railway. Gold was discovered in the reefs here by Prospector Dickie in 1904, and about 157 oz. were dollied before the end of the year. During 1905, 581 tons were crushed, for a return of 823 oz. 15 dwt. 6 gr., valued at £2,632 12s., and, during 1906, 541 tons for 586 oz. 9 dwt., valued at £1,876 12s., making a total of 1,122 tons of stone of an average value of £4 per ton.

The field can now be reached by buckboard coach, running fortnightly from Laura. For the first 60 miles the road passes over heavy sandy country, the result of the weathering of upper cretaceous sandstones, crossing the heads of numerous tributaries of the North Kennedy and Normanby Rivers, flowing to the east coast. These streams gave water at the time of year when the writer visited the field (end of June), at stages of from eight to twelve miles, notwithstanding the poor season. During the latter half of the year, however, the track becomes very dry. About 64 miles from Laura the divide between the eastern waters and the head of the Alice River, which flows into the Gulf of Carpentaria, is passed over, but is almost imperceptible to an unobservant traveller. Granite country is then passed over for the next 20 miles, till the field is reached.

There are two main lines of reef—the Alice Queen line and the Peninsular King line—situated about half a mile apart in a north and south direction, and with practically the same strike in that direction, so that the two reefs would appear to be on the same line.

The Alice Queen Reef.

On the Alice Queen reef a shaft has been sunk to a depth of 112 ft., on a reef some 6 ft. in thickness, from which, up to the present time, some 661 tons of stone have been crushed, for a return of about £3 18s. per ton. Down to about the 76-ft. level the crushings average about £4 11s. per ton.

A drive at the 100-ft. level was carried in to the south about 24 ft., where the reef pinches to about 1 ft. in thickness. The drive to the north was stopped about 6 ft. from the shaft, owing to trouble with the ground on the hanging-wall. It showed about 6 ft. of reef in the face. The stopes above this level to the south and the shaft, from 76 ft. down, have given about 300 tons of stone, worth about £3 11s. per ton. About 20 ft. north of this shaft another, called the No. 1 North, was put down, but there is no record of the amount or value of the stone taken from it, nor was I able to inspect it.

The lower value of the stone below the 75-ft. level is perhaps accounted for by the fact that it was mineralised stone, from which the gold extraction could not have been complete with the battery in use.

Considering the width of this reef and the value of the stone, it should be worth more vigorous prospecting, by driving along the reef, than it is getting at present. The shoot of good stone worked down to the 100-ft. level is comparatively short, as evidenced by the small amount of stone raised up to the present, but it is at least possible that other good shoots may be developed by further prospecting.

The Peninsular King Reefs.

On the Peninsular King line of reef several shallow shafts have been sunk, but only one—that on Dickie's Reward Claim—was working at the time of my visit. This shaft was 45 ft. on the reef, and almost vertical. At 35 ft. the reef had been driven on about 10 ft. to the north, but, the ground having fallen in, the reef could not be inspected. The level was also driven on the reef for about 25 ft. to the south of the shaft, and showed about 2 ft. of reef in the face. About 59 tons of stone from this shaft has returned 158 oz. gold, worth about £505, so that the average value of the stone hitherto raised has been about £8 10s. per ton.

This reef appears to be worth systematic prospecting. A few yards east is a reef about 30 ft. across, from which a small crushing was taken, but as the stone was mixed with that from another shaft, the value was not determined.

About 200 ft. south of the Reward Claim and across the creek, apparently on the same line, a big white reef of quartz was sunk on in *No. 5 South Peninsular King Claim* to a depth of 42 ft., and the reef was stoped out to the surface for 6 ft. north and 10 ft. south of the shaft, those limits bounding the good stone. From this work 197 tons of stone were crushed, and returned 309 oz. of gold, giving an average value for the stone of about £5 per ton. Stone of a value of $\frac{1}{2}$ oz. to the ton is said to be still in the bottom and in the face. Judging from the amount of stone that has been crushed, the reef must be nearly 3 ft. in thickness, and notwithstanding the shortness of the shoot of good stone, the reef there should be well worth further development. Between Dickie's present shaft on the P.C. claim, above described, and the No. 5 South claim, the reef has been proved by a shaft sunk in the bed of the creek, which gave 37 oz. of gold from 32 tons, so that the permanency of the reef between the P.C. shaft and the No. 5 South shaft is pretty well established.

About 100 ft. south of the No. 5 the same reef, here about 2 ft. wide, was sunk on to a depth of about 15 ft., and gave 10 oz. of gold from 14 tons of stone, which, with carting at 8s. per ton, and crushing at 25s. per ton, proved too poor to pay.

About 100 yards west of Dickie's present shaft another reef was sunk on in No. 1 shaft, and about 10 tons gave $\frac{1}{2}$ oz. to the ton, which proved too poor to be payable.

The average value of all the stone crushed up to the present from the Peninsular King claims has been over £5 per ton. The reefs crop out strongly on the surface, and show every sign of permanency with depth. The best stone apparently does not run uniformly through the reefs, but their indications of permanency and large size should make them worth systematic development, with a view to ascertaining what quantities of crushing stuff would be available for a well-designed and economical system of mining and treatment.

III.—THE HAMILTON GOLDFIELD.

1. YARRADEN.

The Golden King Line.

This is a line of reef running about north-north-west through granite country, and standing practically vertical.

On the P.C. Claim, now embraced in Gold Mining Lease No. 10, a shaft has been sunk to a depth of 212 ft. At 106 ft. a level goes north for 89 ft., where a fault was met with, throwing the reef a few feet to the eastward. This fault was met with at about the same distance from the shaft in the level above at a depth of 45 ft. The ground on this side of the shaft has been all stoped out from the

45 ft. upwards. Below that is a solid block of ground, not yet touched, to within 16 ft. of the bottom level, to which point it has again been stoped out from that level. In stoping from the latter level the reef was found to pinch at this height, and was left for a more opportune occasion before being broken down.

The 106-ft. level south has been driven 75 ft. to the boundary of the claim with No. 2 South, and the reef above all stoped out, except about 100 tons of stone still left on the boundary between the two levels.

Below the 106-ft. level the shaft has been sunk, with a slight underlie to the west, to a depth of 212 ft. From the last 94 ft. of sinking 130 tons of stone were obtained, and gave a return, on crushing, of 228 oz. 4 dwt. of gold. As the shaft was about 12 ft. across, this shows an average of about 20 in. of reef. As the gold here is worth about £2 12s. per oz., this stone was worth about £4 11s. per ton.

No. 1 South claim workings adjoin the P.C., the two being now embraced in Gold Mining Lease No. 10. The reef has all been stoped out on this ground to a depth of about 80 ft., over a length of 200 ft., from two shafts sunk towards the middle of the ground.

From the P.C. claim, according to the returns given in the Warden's annual reports, 756 tons have been crushed from above the 106-ft. level, for a return of 1,361 oz. 9 dwt. 0 gr. of gold, of a value of £3,539 14s. This gives about £4 13s. per ton, so that the crushing from the sink has been well up to the average.

From the No. 1 South ground 578 tons have been crushed from above the 80-ft. level, for 1,026 oz., of a value of £2,667 12s. This gives an average value of the stone from this ground of about £4 12s. per ton.

There has, therefore, been proved here, to a depth of nearly 100 ft., a continuous shoot of stone, of an average width of about 16 in. over a length of about 350 ft., worth over £4 10s. per ton, and which has returned over £6,000 for the first 100 ft. of sinking. The reef occurs between well-defined walls, and apparently occupies a true fissure in the granite, showing every indication of permanency with depth.

South of the boundary of No. 1 South ground there appears to be a break in the reef, or a barren portion, as a shaft sunk on the No. 2 South ground near the northern boundary found no stone.

On No. 3, No. 4, No. 5, and No. 6 South claims an almost continuous reef on the same line has been worked by a number of shallow shafts over a length of nearly 600 ft., to a depth of from 40 to 80 ft. From these shafts, up to the present, some 1,305 tons of stone have been crushed, for a return of 2,339 oz. of gold, worth £6,081. The reef here appears to be more patchy in gold contents, some of the faces

showing white, poor-looking quartz, which has been left as too low-grade to pay for mining and crushing under present conditions. The value of the stone crushed, however, has averaged £4 13s. per ton, which still leaves a considerable margin for profit if the stone were taken out by economical methods and crushed in bulk. The reef varies from about 6 in. to 15 in. in thickness, and occurs between well-defined walls, showing every indication of a permanent fissure. It will thus be seen that this reef has already furnished £12,000 worth of gold from within 100 ft. of the outcrop. It shows every indication of being able to turn out large quantities of payable crushing stuff at greater depths, if economically developed.

The Savannah Reef.

This line of reef lies about a quarter of a mile east of the Golden King line. The main shaft is 124 ft. in depth, following the reef on a steep underlie to west. At the bottom level the shoot of stone is about 100 ft. in length, lying to the south of the shaft, the reef in the level, a few feet in to the north of the shaft, breaking up into small veins of streaky quartz. In the stopes above the 124-ft. level the reef shows from 1 ft. 6 in. to 2 ft. in thickness.

The ground above the 80-ft. level has all been stoped out for about 100 ft. south of the main shaft. Beyond this the reef has only been worked to the 40-ft. level for about 50 ft., the reef here splitting up into ill-defined leaders of quartz.

The work on this reef down to the 124-ft. level has given 1,359 tons of stone, which have returned 3,616 oz. 8 dwt. of gold, of a value of £9,040. At the time of my visit preparations were being made to sink the shaft a further 100 ft. The first 25 ft. of this sinking was reported to have given 40 tons of crushing stuff, which would indicate fully 2 ft. of reef at this point. Judging from the value of the stone (which has, so far, averaged about £6 13s. per ton), the size of the reef, and length of shoot, the prospects of this mine look hopeful.

The Lukin King Reefs.

The reefs here occur in graphitic quartz schists and talc schists, which have a general meridional strike and steep dips. The reefs occur as lenticular bodies of quartz following the bedding planes of the schists, and are remarkable for the rapidity with which they bulge to large sizes or cut out to nothing. They all lie more or less on the one north-and-south line, but, owing to the twisting of the schists and the absence of quartz in many places along the line, can hardly be affirmed to be the one reef. The greatest amount of work has been done on the No. 1 South claim. Here a shoot of stone about 40 ft. in length has been followed down for about 50 ft. by an inclined shaft (called No. 2 Shaft), dipping steeply to the west. To the north this body of stone, which was about 5 ft. thick at the shaft, pinched rapidly

out, and, though the drive was extended for another 100 ft., no further stone was met with. About 40 ft. south of the shaft the stone cut out against a cross reef, which was worked from No. 1 Shaft, but did not furnish a large quantity of stone. From the main shoot of stone some 1,066 tons of stone were raised, and yielded 1,607 oz. of gold, worth about £5,222, giving an average value of about £5 per ton for the stone.

A crosscut east from the bottom of the shaft met a parallel body of quartz of about the same length and thickness, which is now being mined ready for crushing.

About 108 ft. north of the No. 1 Shaft, and just beyond the end of the drive above referred to, was a body of stone worked down to the 50-ft. level in the P.C. claim. Two other bodies of good stone have been worked, within the next 400 ft., along the line to the north, the total product from the three shafts having been some 270 tons of stone, returning about 300 oz. of gold.

The Gold Mount Reef.

This reef occurs as a lenticular body of quartzite, about 25 ft. across at its widest point. It has been worked for a length of about 500 ft. by means of several shafts, situated mostly on the hanging-wall, where about 7 in.* of quartz of good quality is found. On the footwall another 15 in. has been worked to a slight extent. The reef strikes north and south through schists and slates, of which the quartzite of the reef is apparently merely a lenticular member, consisting of coarser material. The two richer portions on the hanging-wall and footwall may have been the result of subsequent introduction of silica.

About 274 tons of stone have been crushed from along this line, for a return of 705 oz. 4 dwt., giving an average value of about £8 per ton for the stone. As mentioned above, this has come mainly from the hanging-wall vein. A shaft near the northern end of the original P.C. claim has been sunk to a depth of 90 ft. on this vein. A crosscut is said to have been put in across the reef to the footwall vein, and a bulk crushing of the whole 25 ft., consisting of about 20 tons, is reported to have given 14 dwt. of gold to the ton. There is no record, however, of such a crushing in the Warden's books, the last crushing (March, 1906) showing 40 tons for a little over 11 dwt. per ton.

The appearance of this reef and its records should warrant the expenditure of a moderate amount of capital in properly testing its value. The mine lies about two miles north-east of the Lukin King Mine, over a somewhat rough track.

2. EBAGOO LAH.

In the neighbourhood of the township of Ebagoolah reef mining was practically at a standstill, the only underground work going on

* Inadvertently printed 7 feet in "Mining Journal," December, 1906.

being on the Hamilton King Reef, where a tribute party of three were raising stone from a leader in the shallower levels. The majority of the workings could not be inspected, and the only information that could be obtained was second hand, or from the Warden's reports and records of outputs.

The reefs here occur as bedded veins in quartz schists. The shoots of ore are mostly short, and the thickness and gold contents of the veins very variable. The better shoots of ore so far discovered have all been worked out, wherever payable, as far as the water-level, and only in one case has any successful attempt been made to mine ore below the water, the want of capital having prevented the introduction of pumping and winding machinery capable of mining at any depth. On the Caledonia Reef a small winding plant and pump have allowed of the shaft being taken down a depth of 206 ft., but in no other case have greater depths than 130 ft. been reached. Pumps were also installed at the Tasmania and Hidden Treasure Mines, but, either through excess of water or want of knowledge of the machinery, no permanent progress was made.

The following table shows the amounts of stone crushed and gold obtained from the most important reefs in the neighbourhood of Ebagoolah, as recorded in the Warden's annual reports up to the end of 1906:—

	Stone Crushed.		Gold Returns.	
	Tons.		Oz.	dwt.
Caledonia	2,574	...	2,641	19
May Queen	1,996	...	2,574	5
Hamilton King	1,535½	...	2,258	9
Hit-or-Miss	1,072	...	2,157	3
Hidden Treasure	1,500	...	1,511	3
All Nations	494	...	1,221	8
Golden Treasure	859	...	1,118	16
Violet	560½	...	1,464	16
Trafalgar	420	...	892	6
	11,011		15,840	5

TABLE SHOWING RESULTS FROM MAIN LINES OF REEFS NEAR EBAGOOLAH.

This shows a return from nine lines of reef of 11,011 tons of stone, of a value of over £47,000,† giving an average value for the stone of about £4 6s. per ton.

The Caledonia Reef.

This reef stands with a slight underlie to the west, and has been mined by a shaft following the underlie to a depth of 206 ft. from the surface.

At 60 ft. from the surface a level has been driven south for 100 ft., and the ore stoped out to the surface. North, this level is said to have been driven about 90 ft., and the ground stoped to the

† Inadvertently given as £15,840 in "Mining Journal," December, 1906.

surface. At 90 ft. a second level was driven north a distance of 50 ft., where the reef was faulted, the drive coming up against a clearly-defined wall striking diagonally across the drive and making an obtuse angle on the hanging-wall side. The ground above this level has been stoped out up to the 60-ft. level. At the 152-ft. level north the same fault is met with at 87 ft. from the shaft, and a great portion of the stone above it to the 90-ft. level has been stoped out.

To the east of the shaft, at the 152-ft. level, a short drive shows a large body of white stone, about 18 in. of which is said to be worth crushing. In the sink below the 150-ft. level a large body of stone was sunk on, but carried very little gold, the shoot of gold-bearing stone evidently crossing the shaft above that level from south to north.

This reef has given about 2,574 tons of stone above the 150-ft. level, which has yielded 2,641 oz. of gold, worth £7,586, showing an average value for the stone of nearly £3 a ton. This indicates an average thickness of about 2 ft. of crushing stuff over a length of about 100 ft. of a shoot of stone as far as the workings have gone at present. The great irregularity in the richness of the reef, however, and faulting of the ground to the north have increased the troubles of working to such an extent that it is difficult to form any opinion as to the prospects of success with further sinking. The prospects of finding the reef north of the fault are, however, worth the expenditure of a little money. This continuation does not appear to have been traced on the surface, and might possibly be revealed by trenching across the line in that direction.

The May Queen Reef.

On the *May Queen* an underlie shaft has been sunk on the reef dipping at an angle of about 60° to the east to a depth of about 95 ft. and the reef driven on at that depth 45 ft. north and 35 ft. south, and the stone stoped out from the surface to this depth. The ground below the level was also stoped out for another 5 ft. down by underhand work. This work gave 1,996 tons of crushing stuff, from which it may be judged that the reef averaged about 4 ft. thick over a length of shoot of about 90 ft. The average value of the gold is returned as about £2 9s. per oz., giving an average value for the stone of about £3 3s. per ton, and a total value for the 100 ft. from the surface of £6,306.

The shaft was continued below the 95-ft. level a distance of another 45 ft., but the reef was lost in the first 5 ft. This portion of the shaft was inaccessible, so that it is impossible to say what has caused the loss of the reef in the lower levels. It seems probable, however, that it would be picked up again by crosscutting at the bottom. As yet the water-level has not been reached. The shaft is in good order to the 95-ft. level, being about 11 ft. by 4 ft. and well

timbered. The reef occurs in mica schists, and apparently runs along the bedding planes of the country rock. At the southern end of the 95-ft. level about 1 ft. 6 in. of white quartz is showing, which should be worth driving on.

The Hamilton King Reef.

On the Hamilton King reef a shaft has been sunk to a vertical depth of 60 ft., where the footwall of the reef was struck. Levels were driven north about 60 ft. and south about 50 ft., and the reef stoped out up to the surface. The ore on the northern side was also stoped out underhand below the level for a depth of from 15 ft. to 20 ft. The shaft was then sunk a further 70 ft. below the No. 1 level, and a level driven at 56 ft. for about 20 ft. to the south, but the stone was not payable, and the mine was abandoned. From the stopes down to the 60-ft. level and the underhand stoping to the north below that level 1,535 tons of stone were obtained for a return of 2,258 oz. 9 dwt., worth £6,775 7s., showing an average value for the stone of about £4 8s. per ton.

The Hidden Treasure Reef.

This reef occurs in gneisses and schists, and apparently follows a bedding plane of the country. It has been worked to the water-level (about 40 ft.) over a length of about 300 ft. by a number of shallow shafts. In only two shafts was there any attempt made to mine below the water-level. Of these, the northern one was sunk to a depth of 90 ft., and levels were put in at a depth of 60 ft. to distances of 45 ft. north and 25 ft. south, and the ground stoped up to the old surface workings, here about 35 ft. in depth. From this work 158 tons of stone is reported to have been crushed for 159 oz. of gold, which points to an average of about 12 in. of reef, worth an ounce to the ton. About 180 ft. further south the second shaft was sunk to about 90 ft. by means of a pump supplied by the Government; but below the water-level the reef is reported to have been too poor to be remunerative, and no stoping was done. The total returns show an average value for the stone of about £3 per ton, and, judging from the amount of material crushed, the reef must have averaged well over 12 in. in thickness.

The Hit-or-Miss Reef.

On the *Hit-or-Miss Reef* a shaft has been sunk to a depth of 130 ft. on the underlie, dipping steeply to the west. At about 50 ft. a level was driven south for 30 ft., and the stone stoped up to the surface. Beyond this distance the reef pinched, but was followed in for another 10 ft. To the north a level at 30 ft. was driven for about 100 ft., and the ground stoped out to the surface. Good ore was found underfoot, about 40 ft. in. This was followed down to the 94-ft.

level, opening out as it went down towards the north till, at the lower level, the shoot was about 30 ft. in length, and showed about 9 in. of quartz in the face 70 ft. from the shaft.

The level south at 94 ft. was driven on stone for about 50 ft., and stoped up to the 50-ft. level, the face of the stopes going back as they went up till they met the end of the upper level. This part of the mine was inaccessible. An attempt was made to underhand stope below the 94-ft. level to the south; but after taking out about 6 ft. the water proved too much for the pump, and the work was abandoned. From a second shaft, sunk 42 ft. further south to a depth of about 30 ft., a few tons of ore were also obtained.

The returns show about 1,072 tons of stone from these workings, worth about £6,471, and thus averaging about £6 per ton. The trouble with water seems to have been the cause of abandonment of such a promising mine.

The Violet Reef.

This reef lies about seven miles due south of Ebagoolah, on the road to Yarraden. The reef strikes north and south through granite country, and underlies at about 70° to the west. The stone runs generally from about 1 ft. to 2 ft. in thickness between well-defined walls of granite. On the P.C. claim, the main shaft is 80 ft. in depth, and was worked by means of a whip. At that depth a level was driven south for 30 ft., and the stone stoped out to a height of 30 ft., being still solid above. To the north a level was taken in at the 40-ft. level, the reef being still untouched below, and the stone all stoped out between here and the next shaft to the north, called Marr's Shaft, a distance of 105 ft. off.

Between here and the next shaft, called the Tributer's Shaft, 75 ft. further north, the reef has been driven on at the 35-ft. level, but no stoping done, except near the latter shaft. The roof of the level was falling in, and could not be inspected. About 18 ft. of the reef south from the Tributer's Shaft has been stoped out from the 35-ft. level up, and shows 20 in. of solid stone between well-defined walls at the end of the stope. To the north a level at the 35 ft. goes about 27 ft., and the reef has been stoped out from here up to the surface. The level has been extended another 18 ft. north, and shows about 20 in. of solid reef between well-defined walls.

It will thus be seen that this reef has been worked from three shafts over a length of about 250 ft. From these shafts 560 tons are recorded as having been crushed, for a return of 1,464 oz. 15 dwt. of gold. This represents an average of 2 oz. 12 dwt. per ton; but, although not recorded, I understand that the value of this gold was only about £2 per oz.; so that the value of the stone was not more than about £5 4s. per ton. From the amount of work done, and the

stone crushed, I should judge that the reef, where worked, has averaged about 18 in. in thickness. Considering the length along which gold has been found on this reef, and the evidences of permanency, it appears to be well worth more systematic development below the water-level (about 35 ft.) than can be effected by bailing with a whip horse.

3. POTALLAH CREEK.

The Perseverance Reef.

This is the only reef that has been worked in this neighbourhood. It strikes about north and south, and dips steeply to the west, lying in slate country, with about the same strike. It has been worked down to a depth of about 40 ft. over a length of about 80 ft., and this working furnished 584 tons of stone, which returned some 587 oz. of gold. There is no record of the value of the gold, but, taking it at £3 per oz., this would give a value to the stone of about £3 per ton. Judging from the amount of stone crushed, the reef has averaged about 2 ft. 6 in. over the 80 ft. of working.

The reef was found in 1902, and a small battery was erected in 1904. The battery was removed at the end of the year, and the mine has been idle since.

The mine lies on a tributary of Crosbie Creek, about 25 miles west-north-west of the Alice Goldfield, and 50 miles south-south-west of Yarraden. Its isolated position accounts perhaps more than anything for its having been abandoned after having furnished £1,700 worth of gold above a depth of 40 ft. It can be reached by a good dray road either from the Alice or Yarraden.

IV.—THE COEN GOLDFIELD.

The Great Northern Mine.

The only mine working here at the time of my visit was the Great Northern. The main shaft is on the original P.C. ground, which has now been amalgamated with the No. 1 South ground to the south and the Abdulla and Victoria ground to the north. Down to the 190-ft. level the ground has been nearly all stoped out for a distance of 280 ft. to the south and 270 ft. to the north. At a depth of 275 ft. levels were again opened out and driven on stone to distances of 280 ft. north and 300 ft. south, and the reef all stoped out to the No. 2 level. To the north the stope is thus 10 ft. beyond where the reef was left in the No. 2 level, being at that time unpayable. The No. 2 level has now been proved here, and the stope is being carried on up above it.

From this block of stone above the 275-ft. level, and over a length of nearly 600 ft., some 17,407 tons of stone have been crushed,

worth about £86,234. This gives an average width of about 18 in. of crushing stuff down to the 275-ft. level, worth on an average nearly £5 per ton. Before 1899 this line of reef was worked as four claims—the Abdulla and Victoria to the north, and the No. 1 South to the south; and the average of all the stone got from above the 190-ft. level was about £3 18s. per ton. These claims were amalgamated in the latter end of that year, and since then 9,948 tons of stone have been obtained—a great part from between the 190 and 275 ft. levels—the average value of the stone since that time having been over £5 14s. per ton. This increase in value has apparently been caused by the discovery of several rich patches of stone between the 190-ft. and 175-ft. levels, which have very much increased the average return of the material crushed.

The shaft has recently been sunk to a depth of 375 ft., and levels had been driven north 181 ft. and south 140 ft. at the time of my visit. The reef in the shaft at this level and in the levels themselves shows about 3 to 4 ft. of quartz, but is too poor to pay for crushing, and it has all gone over the tip. On the north side, however, a winze was sunk from the 275-ft. level, at a distance of about 120 ft. from the shaft, on fair stone, to about 60 ft., and a level was being driven north and south at this depth.

Since my visit also I understand that good stone has been struck in the continuation of the drive at the bottom level to the north. Otherwise, however, the developments below the 275-ft. level in this mine have not been as remunerative as in the higher levels.

WALTER E. CAMERON.

Brisbane, 1st December, 1906.

26739

Queensland.

DEPARTMENT OF MINES.

Geological Survey of Queensland.
PUBLICATION No. 210.

**THE ANNAN RIVER TINFIELD,
COOKTOWN DISTRICT.**

WITH ONE MAP AND FOURTEEN PLATES.

BY

WALTER E. CAMERON, B.A. (Cantab.),
ASSISTANT GOVERNMENT GEOLOGIST.



BRISBANE:

BY AUTHORITY: GEORGE ARTHUR VAUGHAN, GOVERNMENT PRINTER, WILLIAM STREET.

1907.

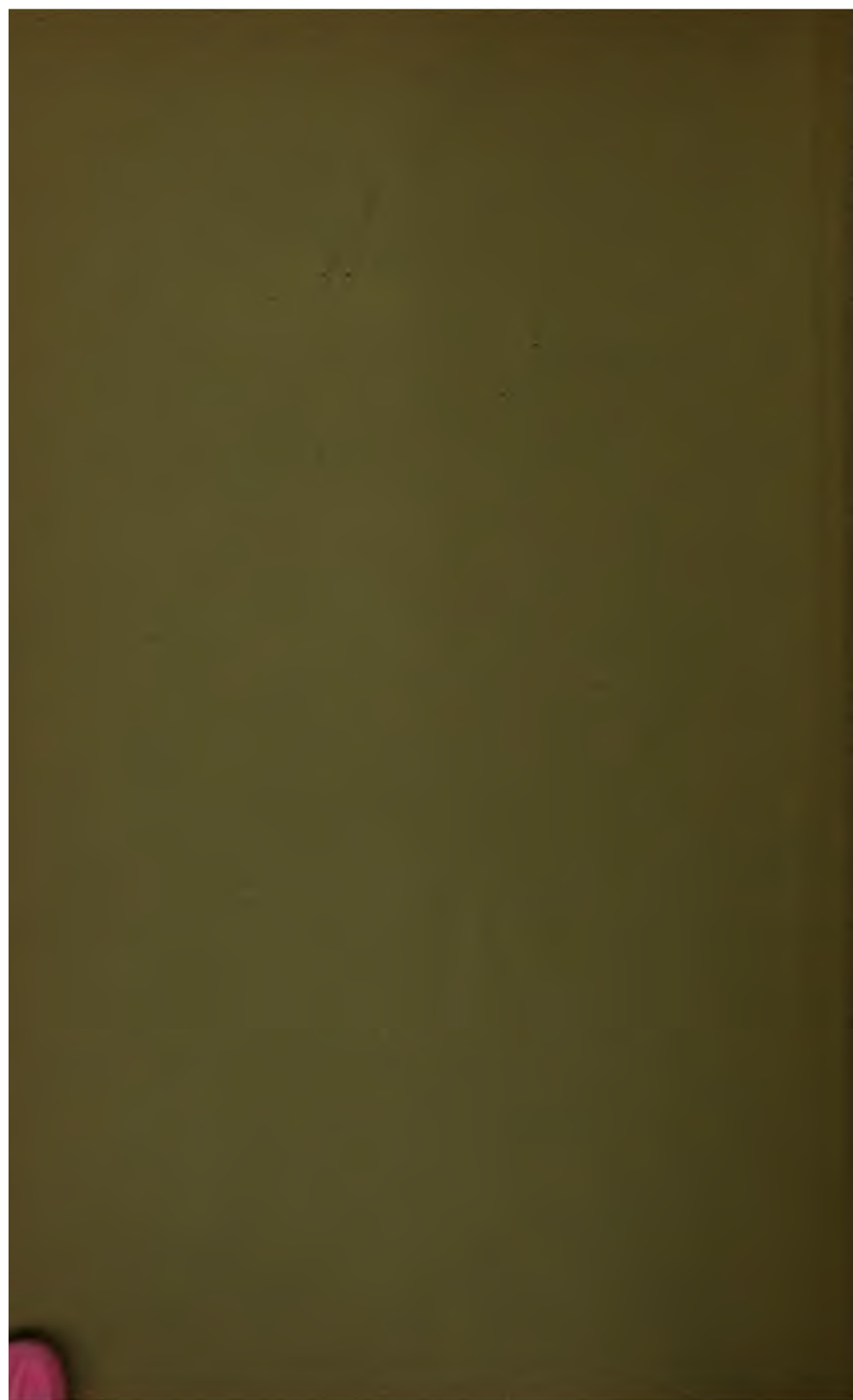


Plate I.



HOME RULE FALLS, UPPER ANNAN RIVER, COOKTOWN DISTRICT.

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SKETCH MAP OF THE ANNAN RIVER TINFIELD SHOWING AREAS SURVEYED AS
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THE ANNAN RIVER TINFIELD.

COOKTOWN DISTRICT.

I. LOCATION, ACCESSIBILITY, AND GENERAL FEATURES.

The Annan River Tinfield covers an area of about 100 square miles of mountainous country bordering the sea coast between the mouths of the Annan and Bloomfield Rivers, south of Cooktown. This mountainous country is bounded on the west by the valley of the Annan River. The river for the first 25 miles of its course flows in a northerly direction parallel with the coast, and at a distance of from eight to ten miles from it. About four miles south of Cooktown the river takes an easterly bend, and, flowing through more level country, enters the sea in Walker's Bay, just south of Mount Cook. The mountainous country of the tinfield forms the upper sources of the river, the drainage being mainly towards the west into the river, leaving only short and rapid watercourses on the fall to the coast. The mountains culminate in Mount Finlayson, near the sources of the river, at a height of over 3,500 ft. above the sea, while Mount Hartley, at the source of Wallaby Creek, and Mount Amos, at the source of Trevethan Creek, are both well over 2,500 ft. The tin claims, with the exception of a few on the eastern slopes of Mount Amos, are all situated on the various branches of the westerly-flowing tributaries of the Annan, which have cut their way back into the hills to within a mile or two of the coast, and thus afford easy means of access from the main Cooktown to Bloomfield road, running up the Annan River and giving communication with the port of Cooktown.

The main road from Cooktown crosses the Annan River about five miles out by a fine low-level bridge, and can be used for wheeled traffic as far as Mount Leswell, 25 miles to the south, after which it is merely a pack track, though drays have been taken out as far as Romeo, six miles further south, near the sources of the river.

About 12 miles out from Cooktown the first branch road turns off to the left, leading to Mount Amos. Running up Trevethan Creek, it reaches the claims at the head of that creek and on the eastern slopes of Mount Amos in another ten miles. About 17 miles south of Cooktown a second branch road to the left turns off up Mungumby Creek to the Tableland claims at the head waters of that creek, about 1,200 ft. above the river valley. Just beyond the junction of Wallaby Creek with the Annan, five miles past Helenvale public-house, and 26 miles from Cooktown, a third branch road turns off to the left, running up Wallaby Creek, and reaching, in another five miles, the

settlement of Rossville, the centre for numerous claims up the different branches of this creek. The main road continues along the river bank as far as Leswell, where a fourth branch road turns off up Leswell Creek. This road has lately been put in order by the Collingwood Company, to communicate with their sluicing ground below the old Mount Leswell Mines.

From Mount Leswell turnoff onwards the main Bloomfield road is used only as a pack track. Branch tracks go off to Shipton's Flat workings, on Parrot Creek, and on to Finnigan's workings, some 2,000 ft. above the sea on the western fall of Mount Finlayson. Further on the track bifurcates, one branch going on through the Grass-tree workings direct to settlements at the mouth of the Bloomfield River, while the other branch, going round by the Romeo and Jackaroo workings, joins it again beyond Grass-tree.

The greater part of the tin from the field and the returning goods are packed right to and from Cooktown, though quite recently the extra business caused by the erection of the Collingwood Company's race at a cost of some £8,000 or £10,000 has led to a considerable increase in the amount of wheeled traffic on the road as far as Leswell.

The field was last reported on by an officer of the Geological Survey (Dr. Jack) in 1891, the report being accompanied by a geological sketch map showing roughly the position of the various lodes then being worked and the boundaries of the geological formations. Since that date our knowledge of the topography of the district has increased very little, except that the surveying of a number of dredging claims along the Annan River and several of its main tributaries has made that knowledge more accurate in these localities. The accompanying map, on a scale of approximately a mile and a half to the inch, gives the positions of these dredging claims.

II. GENERAL GEOLOGY.

The mountainous country of the tinfield is made up of the weathered remains of the northern prolongation of a mass of plutonic granite, which was once covered with altered sedimentary strata, into which it forced its way from below. On account of their greater susceptibility to attack by weathering agents these sedimentary beds have been worn off from the granite, till they are now found only in the lower country encircling it, at depths of as much as 3,000 ft. below its highest points. The denuding agents which have accomplished this work have subsequently carved their way into the once solid mass of granite, and have given rise to the present high relief of deep glen and rugged mountain. The sides of these mountains are clothed with dense scrub, which along many of the watercourses stretch down into the valleys below and in many cases have rendered the task of prospecting the ground and working the alluvial flats increasingly difficult.

The granite area is shown on the Geological Map of Queensland as stretching across the Bloomfield River for another 20 miles south of the area under consideration. It extends here to a width of 20 miles across, forming the rough jungle country at the head of the Bloomfield River (known here as the "Roaring Mag"), and rising, in Mount Peter Botte, to a height of 3,300 ft. The alluvial tin claims of the Bloomfield Scrub and China Camp lie in this little-visited area, which is very rugged in character and covered with thick scrub, rendering it exceedingly difficult to properly prospect. Very possibly other areas yet await development in this direction. My time did not allow of a visit to this locality.

Tin lodés have been worked on the slopes of Mount Amos, at the Lion's Den on the Tableland, at the Collingwood, and at Mount Leswell, but so far without any marked success, and little work has been done on them for a number of years. Recently prospecting work has been resumed on the old Mount Browning lodes at Mount Amos, and I understand that the Collingwood Company propose shortly to open out again on the lodes of the old Collingwood and Mount Leswell Mines.

The lodes about Mount Amos lie along parallel joint planes of the granite, and are due to alteration of the granite walls of the joints by mineralising vapours or solutions that have been forced into them from below. They are characterised by intense tourmalinisation and silicification of the granite along the joint planes, the zone of alteration in some cases occupying a width of as much as 10 ft., and being traceable at detached points along the joints for considerable distances. The persistency of the joints and the possibility of picking up tin-bearing material at numerous points along a considerable length in one straight line has led to the idea in some cases that these tin-bearing joints are continuous lodes of ore. This inference, however, cannot be relied on, as the width of the zone of alteration to lode matter and its richness in tin contents vary rapidly from place to place, and, as far as can be seen at present, the shoots of ore are not very long.

The number of these joints, with their veins of tin-bearing tourmaline and quartz running up the sides of Mount Amos, must be very numerous, as the gravels down its sides and in the flatter ground along Waterfall (or the Main) Creek, which have been worked for many years for alluvial tin, are composed very largely of pebbles and boulders of quartz and tourmaline, which have evidently been derived from these veins.

In the old alluvial workings on the slopes of Mount Leswell the same prevalence of tourmaline boulders is noticeable, as well as in the heaps of mullock around the old shafts; but no examination can now be made of the old workings.

At the Lion's Den (Tableland) a similar character of mineralisation along the numerous parallel joints of the granite can be noticed. It seems likely that the greater part of the tin of the gullies and creek flats has been derived from the degradation of innumerable small veins along the joints of the granite, of which those worked at Mount Lesswell, the Lion's Den, and Mount Amos, on account of their greater size and exposed position, have attracted attention, while others of less prominence have, on account of the thick growth of scrub and the depth of surface soil, escaped notice.

III. THE ALLUVIAL DEPOSITS.

As mentioned incidentally before, the country of the tinfield consists of an area of rugged mountains diversified by deep valleys running back into and surrounded by them, this carving out of the granite having been more pronounced in the valleys draining to the west into the Annan River. In the upper portions of their courses these streams are characterised by comparatively moderate slopes, with sufficient meandering of their courses to allow of the formation of numerous beaches of tin-bearing gravel and their preservation by the accumulation over them of considerable depths of alluvial. Of these higher beaches, situated at heights of from 1,000 to 2,000 ft. above the sea, may be mentioned the gravels worked along the upper branches of Mungumby Creek, on the Tableland country, those on the upper branches of Slatey Creek, Mount Hartley Creek, Jones Creek, and other tributaries flowing into Wallaby Creek, the workings at Finnigan's on the western fall of Mount Romeo, and the workings along Grass-tree and Jackaroo Creeks, and the tributaries of the Romeo branch of the river. These higher alluvial deposits are held up by bars of harder rock, which have arrested the erosive power of the streams along their beds, and thus allowed of the corrasion of the banks above them with an accompanying deposition of tin-bearing gravel and sand in the bends. Over these bars of harder rock the creeks plunge, to levels little above those of the river, in a succession of cascades and falls, often of exceeding beauty. Amongst the most beautiful of these may be mentioned the Home Rule Falls, on Slatey Creek, of which a fine view is reproduced on Plate I. Hardly less beautiful are those on Mungumby Creek, Mount Hartley Creek, Parrot Creek, and the Romeo branch of the Annan River. It is these gravels, bordering the upper reaches of the streams flowing into the Annan, which have given the great bulk of the tin from the Annan fields, some of the terraces—such as those at the Tableland, Finnigan's, Jackaroo Creek, and Romeo—having been worked continuously since the opening of the field in 1886. Plate II. is a view of the face of one of these high-level gravels in Wilson and Muir's claim, on Kimberley Creek, at Romeo, which has been worked up from the junction with Romeo Creek for 300 yards.

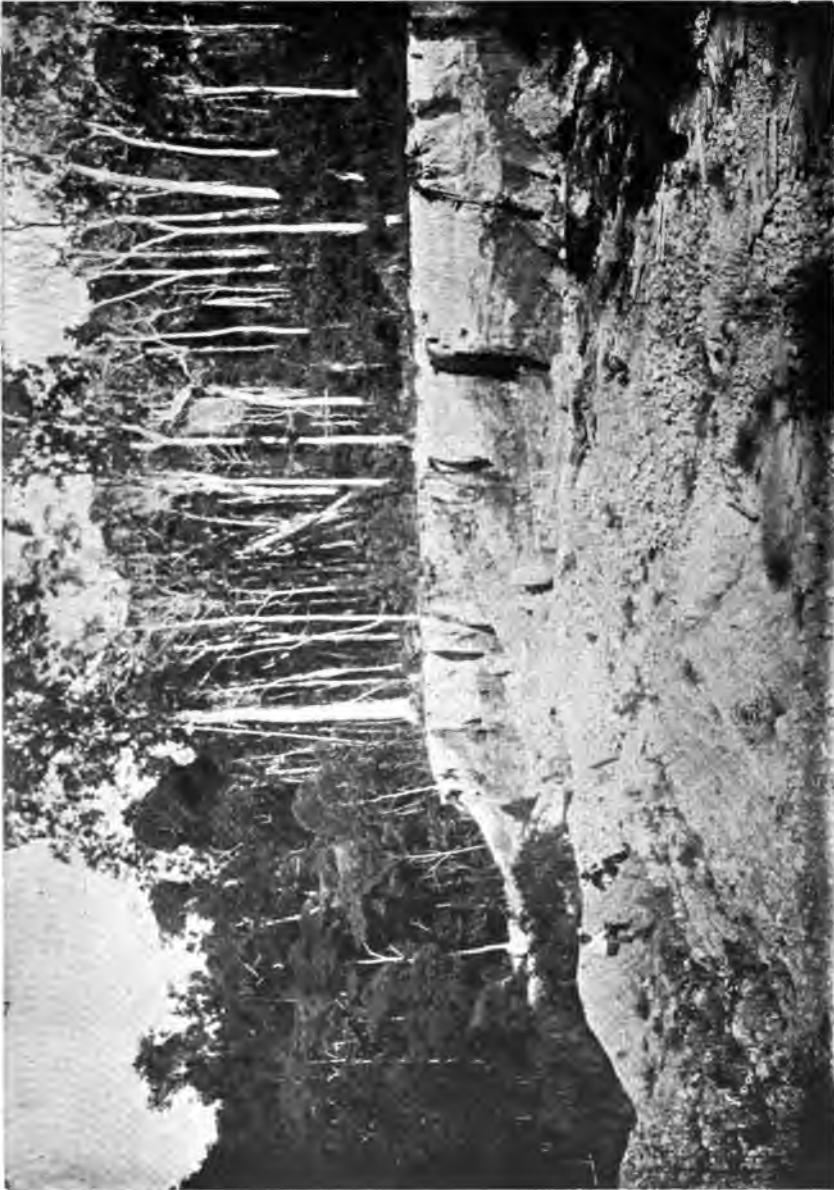


Plate II.

WILSON AND MUIR'S CLAIM AT ROMEO.
WORKED CONTINUOUSLY FOR TWENTY YEARS. KIMBERLEY CREEK ON THE LEFT.

Plate III



**WILSON AND MUIR'S FLUMING OVER BAIRD'S CREEK, ROMEO.
FIFTY FEET ABOVE CREEK LEVEL.**

Below the bars of harder rock which hold these gravels up, and which give rise to the numerous cascades and falls along the main creeks, the streams flow in deep rocky valleys hemmed in on either side by steep hills and mountains, which still give evidence of the former heights at which the streams must have flowed. The streams have, however, here and there along their lower curves—where softer country has given opportunity for lateral corrasion of their banks—been able to pile up accumulations of alluvial, to which attention has of late years been devoted as a source of tin. The more gradual fall of these lower portions of the streams, due no doubt to the fact that they have been carved out by the gradual recession of the fails, and the thickness of stripping of sand often found above the tin-bearing wash, has been a hindrance to economical sluicing by ordinary methods. Since the increase in the price of tin attention has been given to some more economical method of working them, either by hydraulicing the face with water under pressure or by dredging with buckets or suction and thus reducing the cost of moving the over-burden. At present some 2,000 acres of alluvial ground along the river and its numerous tributaries have been taken up for this purpose.

IV. METHODS OF WORKING ALLUVIAL.

SLUICING.

The total recorded yield of tinstone (cassiterite) from the Cook district from 1886 to 1905 has been 7,409 tons, valued at £413,040. The great bulk of this output has come from the Annan River field, and the larger portion has been stream tin won from the upper sources of the streams. The yield was greatest during the first three years, amounting to 1,051 tons for 1888, after which it gradually decreased till, in 1897, it had come down to 146 tons. Since then the return has remained fairly constant, the average for the last nine years having been about 150 tons. The output for 1905 was 142 tons, valued at £12,462.

During the first few years after the first rush in 1886 the tin was won mainly from the beds of the creeks and their immediate banks by sluicing the gravel in boxes with the water coming down the creeks. Any overlying alluvial soil was stripped by hand, and the gravel lifted and wheeled in barrows to the boxes. As the bottom rose above the level at which the water of the creek could be conveniently brought within easy distance of the face, the wheeling became too expensive, and the face was left for other more easily worked places. As these deeper portions along the present beds of the creeks became exhausted, attention was turned to the higher terraces which lay further back, and which could only be worked economically by bringing in water from some higher source, and using it to wash off the alluvial overlying the tin-bearing wash along the bottom by carrying it over the

face of the banks. To do this, races had to be constructed, often of several miles in length, and sometimes necessitating considerable ingenuity in the erection of fluming or piping to carry the water over intervening gullies.

Plate III. gives a picture of a piece of fluming which has been used for the last 16 years to carry water across Baird's Creek at Romeo to Wilson and Muir's claim on Kimberley Creek. The height of the fluming above the bed of the creek is 50 ft., and the length about 150 ft. The uprights are all of round timber, obtained in the neighbouring scrubs, and many of them had to be brought from considerable distances. The size of the boxes is 12 in. bottoms with 10-in. sides, having a grade of 1 in. in 10 ft.

Plate IV. is a picture of a dam on the upper waters of the Annan River supplying water to Bolen and Bathe's claim at Grass-tree, and shows the method adopted for turning the water off into fluming, running along the rocky banks of the creeks and communicating with a race as softer ground is reached.

Recently attention has been turned to several residual deposits lying on the flatter slopes of the hill sides, well away from any water-courses. Here the advantages of an easy getaway for the tailings and the shallowness of the stripping above the wash compensates to a considerable extent for the comparative poverty of the ground. Among these residual deposits that have been worked lately may be mentioned the ground first opened up by Bolen and Bathe above the old workings at Finnigan's, a portion of the ground now being worked by the same men at Grass-tree, and the ground on which hydraulic sluicing has lately been started by Yates at Romeo. The ground recently opened up for hydraulic sluicing by the Annan River Company on the slopes below the Mount Leswell lodes is of the same character.

HYDRAULICING.

This class of ground, on account of the fact that the slope is generally steep, and that the areas of ground are fairly extensive, has possibilities for hydraulic sluicing which have been availed of in the last two cases, and also formerly on Bolen and Bathe's ground at Finnigan's. In the latter case the numerous stones and boulders in the ground gave considerable trouble, and led to the abandonment of this method of working, while at the Annan River Company's workings the same difficulty has been felt. On the Annan River Company's ground the cemented character of much of the ground has also been the cause of much delay, necessitating the breaking up of the ground by blasting before it would yield to the force of water. In this case the company are operating with a pressure of 240 ft. through a 2-in. nozzle. The nozzles, however, supplied up to the present have been faulty in design, causing a spraying of the jet of water, which renders it very deficient in cutting power.

Plate IV.



BOLEN AND BATHE'S DAM AND FLUMING, GRASS-TREE, UPPER ANNAN RIVER.

Plate V.



HYDRAULIC RESIDUAL DEPOSITS, ANNAN RIVER COY.'S GROUND, BELOW LESWELL MINES.

Plate V. gives a view of the ground being worked by the Annan River Company, and shows the spraying of the jet from the moment that it leaves the nozzle. At Yates's claim at Romeo the pressure used is about 100 ft., through a $\frac{7}{8}$ -in. nozzle, but the soil here is loose and friable and almost free of boulders. I was informed that the ground can be broken by the nozzle at a much greater rate than it can be carried through the tail race by the volume of water available from the nozzle, and this method of working has proved well adapted to this ground, entailing a great saving of labour over the ordinary methods of sluicing. Plate VI. gives a picture of the nozzle working on this ground.

Besides the places already mentioned as having been worked by hydraulic, there are several other localities which offer facilities for this method of treatment. Amongst these may be mentioned the ground surrounding the old Bower Bird claim on the tableland, where about 180 acres have been taken up for this purpose, and the ground surrounding the Home Rule claim, near Rossville, where a fine supply of water can be obtained from above the Home Rule Falls, on Slatey Creek, and where, I understand, operations are to be begun as soon as the necessary machinery can be got on the ground.

The greater portion of the ground that has lately been taken up is on the lower flats along Wallaby Creek and the main river. These flats were referred to by Dr. Jack as offering great possibilities, with economical treatment. Up to the present little systematic prospecting has been attempted except in one or two cases, of which I have not been able to get the detailed results. From their position below good tin-bearing ground, these flats, at first glance, show every prospect of carrying payable tin, but it would be impossible to form any definite estimate of their value without elaborate prospecting and a careful consideration of the means to be employed to win the tin in each individual case. The want of sufficient fall seems to preclude the employment of simple hydraulic sluicing in the great majority of cases, and some method of raising the material, either by bucket dredging or by suctioning after hydraulic, and thus allowing of the wash being carried through a series of boxes of sufficient length and fall to allow of the separation of the tin from the soil, will have to be adopted. The depth of alluvial to be dealt with in much of this ground, as well as the character of the bottom and the prevalence of boulders in a good deal of the ground, are elements of trouble which will have to be considered in any scheme of treatment that is proposed.

DREDGING.

In 1898, an attempt was made to dredge a portion of Wallaby Creek, near Rossville, known as the Native Youth claim, where a wide stretch of alluvial ground is held up by a bar of granite. This dredge was on the suction principle, the breaking up of the ground in front of the suction pipe being effected by means of an ingenious revolving

pick actuated by an endless chain from the engine. As far as I can learn, the whole of the material brought up through the suction pipe, containing numerous stones and boulders up to the full width of the pipe, was passed through the boxes in which it was proposed to save the tin. The result was that the rush of water necessary to carry these boulders through the boxes and out behind the dredge was too great to allow of the settling of the tin, and it was found impossible to save it. The dredge was subsequently washed down the creek by one of the floods incidental to the wet season in this district, and has never been re-erected.

The difficulty of saving the tin is one that has been quite overcome in the Stanthorpe dredges by screening out the boulders on a "grizzly" before allowing the wash to enter the boxes, and by having a sufficient length of boxes to allow of the settling of the tin. The danger from floods, however, is one which will always have to be guarded against in any scheme that may be proposed for the lower ground lying along the river and its main tributaries. In view of the numerous difficulties at first experienced in dealing with dredging propositions on the Stanthorpe flats, and the final overcoming of those difficulties by repeated experiment, I do not think that the drawbacks incidental to this class of work should prove too great to allow of considerable amounts of tin being profitably worked from many of these river flats. The necessity, however, of a systematic prospecting of the ground, and a careful consideration of the engineering difficulties to be contended with in each individual case, before incurring a large expenditure in erecting unsuitable plant or attacking ground that cannot be economically worked, cannot be too strongly insisted on.

V. THE LODE WORKINGS.

Lode mining was commenced on the Annan Field about 1887, the Warden's report for that year mentioning the fact that lodes were being worked at Mount Amos, Mount Leswell, and the Upper Annan. Crushing and dressing machinery is mentioned in the Warden's reports as working at the Lion's Den Mine (Tableland) and at the Collingwood Mine in 1889, and at the Mount Browning Mine in 1890. In the latter year the field was visited by Dr. Jack (then Government Geologist), who reported in detail on the work that had been done up to that time, and took a number of samples from the different faces exposed by the workings. Lodes were then being worked at Mount Leswell, Collingwood, Mount Hartley, Lion's Den, Mount Amos, and Mount Browning, the depths, however, being all comparatively shallow.

These mines were abandoned one by one during the next few years, and no serious lode mining appears to have been undertaken since. Numerous causes have apparently contributed to this result, the most important being probably the exhaustion of the richer bunches of the more easily won ore near the surface, and the greater difficulties involved in profitably extracting the ore at lower levels.

Plate VI.



HYDRAULIC RESIDUAL DEPOSITS ON HILL SIDE, YATES'S CLAIM, ROMEO,

Among other causes were, perhaps, the low prices of the metal ruling during the years 1894 to 1898, and the dispersal of the mining population owing to the rich gold finds in New Guinea and on the Starcke River. As the returns of lode tin and stream tin have not been kept distinct, there is no record of the amount that has been derived from these mines; but, judging by the amount of work done, it has not formed any considerable proportion of the total.

MOUNT LESWELL.

The lodes here lie on the western slope of the ridge dividing the head of Baird's Creek, flowing west into the Annan from the head of Jones Creek, which falls north-easterly into Wallaby Creek; and these lodes are now included in Lease 182, shown on the accompanying map. The hill-slopes below the outcrops of the lodes are strewn with boulders of tourmaline-bearing quartz, evidently derived from the lodes. Patches of soil have been worked for the tin shed from the lodes, while the whole hillside is now taken up for the purpose of hydraulic sluicing by the Annan River Company. The workings on the lodes are at present in disrepair.

At the time of Dr. Jack's visit two lodes, called the "Eastern" and "Western" lodes respectively, were being opened up. On the "Western" lode four shafts had been sunk over a length of 130 ft., to a depth of about 35 ft., and were connected by a drive at that depth. Nine samples taken by Dr. Jack along this drive gave, on assay, an average of 4 per cent. of metallic tin. Of these, four samples gave only traces of tin, while two gave over 10 per cent., by which it may be judged that the ore is very uneven in quality. The strike of the lode is about north-west, with a steep dip to the north-east.

On the "Eastern" lode two shafts were sunk to a depth of about 50 ft. each, a distance of 40 ft. apart, and connected by a level at that depth. Nine samples from this lode gave only traces of tin, while one sample gave over 21 per cent.

These lodes are described as consisting of tourmaline and quartz in granite, and as reaching in places to a width of 4 ft., though they are evidently very irregular both in thickness and value. There is no record of the return of ore or metal from the workings on them.

THE COLLINGWOOD LODGE.

This lode, situated near the source of Jones Creek, on the eastern fall of the Collingwood Range, is now embraced in Lease 176, the position of which is shown on the map. At the time of Dr. Jack's visit four shafts had been sunk on it over a length of about 200 ft. to depths varying from 35 to 50 ft. Crosscuts from these shafts exposed a lode of tourmaline and quartz of considerable width, dipping with a flat inclination into the hill and lying at the junction of granite and metamorphic rocks. Ten samples taken by Dr. Jack from various

parts of the lode in 1890 gave an average of 3.75 per cent. of tin. Of these samples, however, only three gave over 2 per cent., the highest result being 19.40 per cent. These results indicate the very uneven value of the lode material. The apparently great width of the lode, however, should make it worth further prospecting. At the present time nothing is being done in this direction, though the present holders intend to commence work as soon as their sluicing works are in fair working order.

THE LION'S DEN LODES.

These lodes are embraced in Lease 186, shown on the map, and are situated on a spur coming down from the Tableland between the two main branches of Mungumby Creek. Several parallel veins in granite have been worked opencast, and irregularly, wherever good tin could be got, much of the material having been hand-dollied and streambed. The residual surface deposits have been all removed and sluiced over a considerable area down the slope of the spur.

At the time of Dr. Jack's visit in 1890 the main lode had been worked by two vertical shafts, situated 97 ft. from each other, in a north and south direction, and connected at a depth of 60 ft. by a level along the lode. The lode was intersected by a cross-tunnel from the side of the hill, at a point 34 ft. north of the northernmost shaft, and the level was continued on south of the two shafts along the lode for a distance of 378 ft. beyond the southernmost shaft. All the payable ore between the tunnel and the southern shaft above the 60-ft. level—*i.e.*, for a length of 130 ft. along the line of lode—had been stoped out, crushed, and concentrated.

The mill was situated close to the mine, and was actuated by a Pelton wheel, driven by water flumed from Byers Creek. The amount of stone crushed at the time of Dr. Jack's visit was 539 tons 3 cwt., for a return of 48 tons 16 cwt. of black tin, giving an average of about 11 per cent. The average width of the reef would thus appear to have been about 1 ft., on the supposition that all the stone came from the stopes between the tunnel and the shafts.

A winze was sunk on the lode, 20 ft. north of where it is intersected by the tunnel, to a depth of 44 ft., but Dr. Jack states that it could not be inspected at the time of his visit. Since then there is no record of any serious mining having been undertaken, though a certain amount of surface prospecting of the other veins was carried on.

This would appear to have been the most remunerative of the lodes worked on the Annan Field, and is the only one of which there is any record of the amount of stone crushed.

THE MOUNT BROWNING LODES.

These lodes are situated on the eastern slopes of Mount Amos, about a mile and a-half from the sea coast. They are included in Lease 189, the position of which is shown on the map, and are known.

to the present owners as the Phœnician. The lodes occur in granite country close to its contact with a mass of slates and quartzites. The lodes crop out down the rocky slopes of the mountain as irregular patches of tourmaline and quartz occurring along regularly-running joint planes of the granite. They are no doubt the result of alteration of the granite walls of the joints by mineralising vapours introduced from below during the consolidation of the margin of the granite mass in cooling.

These lodes were being worked at the time of Dr. Jack's visit in 1890, and several tunnels and shafts are described in his report. The majority of these have now fallen into disrepair, and it is somewhat difficult to identify those that can now be inspected with Dr. Jack's descriptions. During the first few months of this year a little desultory prospecting has been carried on by a Brisbane syndicate, but up to the time of my visit little had been done in the way of further development of the ore bodies.

Dr. Jack refers to several "pipes" of ore above the old mill site and camp, from which he took eight samples of ore. These samples gave, on assay, an average return of nearly 10 per cent. of metal. A shaft, 35 ft. on the "Upper," or No. 5, lode, and a drive 35 ft. north from the bottom showed a shoot of stone about 23 ft. in length, which on being stoped up gave 100 tons of ore. There is no record of the amount of tin obtained from this stone, and the bottom of the shaft cannot now be inspected. A small heap of ore stacked on the surface gave, on being sampled by the writer, no return of tin. A tunnel about 190 ft. lower down the hill meets a second lode in about 20 ft. The lode has been driven on about 12 ft. either way to north and south. The southern face shows about 3 ft. of lode formation, carrying quartz and tourmaline, from which a good prospect of tin was obtained.

The face of the northern drive shows lode material, heavy with tourmaline, over a width of about 6 ft. Patches of coarsely crystalline cassiterite occur along the hanging-wall, but a sample taken right across the face gave no return of tin when assayed at the Government Chemical Laboratory.

About 400 ft. below this tunnel a second tunnel has been driven into a face of rock a distance of about 30 ft. It passes near the entrance from slates into granite. This work was apparently done with the view of cutting a small vein of ore exposed in a shallow shaft some 40 ft. up the hillside. Patches of tourmaline are seen on the roof and walls of the tunnel, but I could not see any indication of a defined lode or vein. About 30 ft. further west the slates have been bared off from the granite, exposing a vein of tin running along the junction of the two rocks. The presence of this vein of ore is traceable to the influence of a joint seam passing into the granite at right angles to its junction with the slate, and along which tin ore can also be seen. This latter vein of ore along the joint has been opened up by a shaft

60 ft. further south, and about 40 ft. up the hillside by a vertical shaft about 9 ft. in depth. It shows a vein having a width up to 12 in. down the ends and in the bottom of the shaft. About $1\frac{1}{2}$ tons of good tin ore have been raised from this shaft.

It will be seen from the above that as yet very little work has been done on the lodes, and that what has been done shows that there is good tin ore in some of them. The quality of the ore, however, is very uneven, and the shoots appear to be short, the ore bodies occurring in "pipes" along joint planes, as pointed out by Dr. Jack in his report. Under these circumstances a great deal more development work will have to be done before even an approximate idea of the value of the lodes can be formed. Judging from the exposures as yet made, some good patches of ore may be expected to be found, but it is extremely doubtful whether the lodes are capable of turning out any large quantity of crushing stuff. The ore so far developed seems to be more adapted to a system of hand-picking and simple and inexpensive concentrating on a small scale than to treatment by any elaborate methods.

VI. THE ALLUVIAL WORKINGS.

An attempt was made in previous pages to give a general idea of the character of the alluvial deposits of the Annan Field. The following paragraphs will describe the various claims and leases in as full detail as the time spent in examining them permitted. It is a matter for regret that these examinations were not made more detailed, but to do that would have involved a very much greater length of time than could be devoted to the work. At the date of my visit the country was practically uncharted, and it was consequently very difficult in such mountainous country to arrive at an understanding of the interdependence of the different features and exposures met with. The study of the field was also somewhat interrupted by calls to other work.

(1.) THE UPPER ANNAN.

Romeo.

The workings here lie scattered up the numerous tributary creeks of the Romeo branch of the Annan River. The Romeo branch heads from a scrub-covered mountain, which I have named on the map as Mount Yates, and which forms the culminating point of Yorkey's Range shown on the Lands Office map of the district. The Romeo branch flows north-westward from here past the now almost deserted township of Romeo, and forms one of the main heads of the Annan.

On the crown of a ridge near its source is *Yates's Claim*, which has been worked as continuously as the supply of water would allow for some fifteen or sixteen years. The ground here consists of residual deposits lying on the crest and down either side of a scrub-covered ridge, the depth of soil running from about 2 ft. to 6 ft. in thickness.

The bulk of the tin has been found in coarse, rounded lumps, getting finer as the lower ground in the various gullies was reached. The floor from which it has been washed shows numerous veins of decomposing porphyry traversing the granite. Alongside of these veins, I was informed, good tin was often got, and the presence of the tin in the surrounding soil is no doubt in great part due to their influence. The claim is at present being worked by hydraulic sluicing along the lower slopes of the ridge about 100 ft. below the summit. This method of working has only recently been applied, and has proved a great saving of time and labour compared with the method of ground sluicing. (Plate VI. gives a picture of the present face.)

The water is brought by means of a race from a distance of about four miles. The source of supply is Granite Creek, falling into the Bloomfield River; and the race has been carried over the divide between it and the Annan waters to the left bank of Romeo Creek. It is then piped across the head of Romeo Creek, the pipes being carried on trestling standing 27 ft. above the creek bed, and rising at the further end to a height of 122 ft. above their lowest point. The pipes are galvanised steel, 4 in. internal diameter, 17 ft. 9 in. in length, and weigh 43 lb. each. They were brought by dray from Cooktown to within about a mile of the work, to which they had then to be carried up by hand some 600 or 700 ft.

The pipes empty into a ditch, which carries the water into a wooden box, into the bottom of which the pipes leading to the nozzle are fitted. These pipes taper from a diameter of 6 in. to $2\frac{1}{2}$ in. at the lower end, where they are attached to 20 ft. of rubber hose terminating in a nozzle $\frac{3}{4}$ -in. in diameter. The vertical height from the box to the nozzle is about 100 ft., and this height gives ample pressure for breaking down the ground.

The proprietor estimates that he can move about 40 loads of material per day, and that for 15 weeks' work he obtained 32 cwt. of tin, equivalent, at present prices, to about £175.

Near the old township are situated *Wilson and Muir's* and *Mahoney and Sullivan's* claims, on Baird's Creek and Kimberley Creek, just above their junction with Romeo Creek. A bar of granite across the Romeo branch below the point where it is joined by the two former creeks has allowed of the formation of a terrace stretching up between the two creeks for a distance of about 300 yards by about 150 yards across. This ground has been worked for the last 20 years, at first by stripping and box sluicing, and subsequently by ground sluicing, with water brought in from about a mile up Romeo Creek.

On Wilson and Muir's ground, on Kimberley Creek, the face is now about 20 ft. in height, and the bottom is beginning to rise rapidly, while the tin is getting poorer, so that the terrace is nearly worked out. Mahoney and Sullivan have worked out the corner of the terrace on

their ground abutting on Baird's Creek, and are now working over old ground in the bed of the creek a few hundred yards further up. Plate II. shows the present aspect of Wilson and Muir's claim, and gives some idea of the character of the ground and method of working it.

There are several claims working the bed of the Romeo branch below the falls at Romeo, and about two miles of the river have been taken up as a dredging claim. The river here flows between rocky banks, which hem it in closely on either side, and have allowed of little room for the accumulation of terraces of tin-bearing gravel except towards the lower end. Here a flat of about four or five acres in extent seems to offer good prospects of carrying payable wash.

Grasstree and Jackeroo.

Grasstree Creek is a short tributary of the main branch of the Annan River about a mile due north of Romeo. The alluvial ground here has been formed behind a bar across the creek a little above its junction with the river. The creek was formerly worked along its bed by stripping and boxing. Recently the ground has again been taken up by Bolen and Bathe, who have succeeded, after many difficulties, in bringing water on to the ground. The water is turned from the Annan River by a dam, a picture of which is shown on Plate IV.

From the dam the water is led through 20 chains of fluming, part of which is shown in the picture, then by four chains of race to piping, which carries it across the valley of Stoney Creek. There is 1,800 ft. of this piping. The pipes are 6 in. in diameter, of spiral rivetted steel, and had all to be packed and carried up from the Bloomfield River over Stuckey's Gap, a height of about 1,300 ft. above the sea. The next 800 ft. is box piping, 7 in. by 6 in. square. Unfortunately the claim-holders were not financially strong enough to carry their steel pipes right through, and laid this wooden piping, with a rise of 33 ft., to the outlet, thus giving a pressure of over 15 lb. to the square inch. This was too much for the wooden pipes, which burst as soon as the water was led through them, thus entailing considerable delay and expense in raising the piping from the lowest point to give a rise in the box piping of only about 3 ft.

The pipes deliver into a reservoir 40 ft. by 50 ft. by 8 ft. deep, cut in a granite soil on the crown of a ridge. From here it is distributed to the three faces at present being worked. The water supply to these workings was completed about the end of May last, and for the first five weeks after starting to work four men cleaned up 25 cwt. of tin, worth about £125, which thus gave them over £6 per week per man.

The low grade of fall of the creek for some distance above the bar of granite behind which the tin-bearing ground has been formed retards the getting away of the tailings. This has been obviated to

Plate VII.



DAM AND SLUICE GATE ON PARROT CREEK, ANNAN RIVER CO.'S RACE.

some extent by cutting a channel 5 ft. deep by 1 ft. in width for a length of $2\frac{1}{2}$ chains through the solid granite bar, but even this gives hardly sufficient fall to allow of expeditious work, and the claim-holders intend to lower it another 6 ft. or 7 ft. as soon as they are in a position to do so.

Stoney Creek and Jackaroo Creek join each other about half a mile before reaching the river, which they enter about a quarter of a mile above Grasstree. Along these creeks are several claims, all working in dense scrub. Stretches of alluvial lie along the beds of the creeks, separated by rocky bars. As a rule, they are not of any great width, though immediately below the junction of the two creeks, and about a quarter of a mile above the junction with the Annan, there is an area of about 40 acres where several tributary creeks enter Stoney Creek. This area has been taken up for dredging purposes as the Lindsay No. 2 Dredging claim. The alluvium is here in places as much as 6 ft. in depth. It appears to be well suited for treatment either by hydraulic or dredging.

Further up along Stoney and Jackaroo Creeks another 100 acres have been taken up in narrow strips, along the creek beds. This ground shows every indication of carrying good tin, and of being suitable country for hydraulic work. It does not appear, however, to have been systematically prospected.

Finnigan's.

The ground worked here lies down the western slopes of Mount Romeo. The mountain is marked thus on the Lands Office two-mile map of the district, though it is not generally known on the field by that name. The workings are reached by a track branching off from the main Bloomfield track near Shipton's, on Parrot Creek.

The greater part of the work has been done along the course of a creek draining down from the mountain side, where its fall has flattened to some extent and has allowed of the deposition of about 10 acres of rough bouldery wash. This ground has been practically all worked out, though two men are again turning over the old bed of the creek and getting tin.

Higher up the mountain side an area of residual soil, lying on a slope of about 30° , has been opened up of late years, and is now being worked successfully. This has been rendered possible by bringing in water from higher up the mountain side. This was accomplished by Bolen and Bathe, of Grasstree, by the erection of light fluming tapping the sources of creeks falling towards Grasstree. The length of the fluming is about 116 chains to the storage dam, above the workings. The height of the intake of the fluming is given as 3,300 ft. above the sea-level, while that of the dam above the claim of Rainer (the present owner) is given as 2,200, showing a drop of 1,100 ft. in the 116 chains, or an average fall of 1 in 7.

The arduous character of the work involved in the construction of this race by two unskilled men may be judged from the fact that the 1,500 superficial feet of planks used in its construction had all to be pit sawn on the mountain side, and carried along the race to the points where they were required.

The sizes of the boxes are 6 in. at the bottom, with 5-in. sides, the great fall allowing of such a small section of flume carrying ample water for the work.

It was mentioned previously that an unsuccessful attempt was made to sluice the ground under hydraulic pressure with the water from this flume. The failure was ascribed to the number of boulders present on the wash. As the pressure employed, however, was only about 25 ft., this method of working can hardly be said to have had a fair trial. As a much greater pressure could be easily arranged for, the great slope of the ground should render it eminently suitable for hydraulic sluicing.

Shipton's.

The workings here lie along tributary streams draining into Parrot Creek about half a mile above the point where it joins the main branch of the Annan River at the Little Forks, and about the same distance east of the main Bloomfield track. This junction is about half a mile above that of the Romeo branch, but Parrot Creek comes in on to the right bank. For about half a mile above the junction Parrot Creek runs through a rocky channel, being hemmed in on both sides by steep banks. Above this point the valley widens out for another mile, the creek winding through an alluvial flat, which has lately been taken up as a dredging claim of about 100 acres, known as the Lindsay Dredging Claim. The country here is slate, the softer character of which has allowed of the more rapid erosion of the bed of the stream, with a consequent corrasion of its banks and accumulation of wash and alluvium.

Several claims lie round the margins of the alluvial flat, amongst which the two most successful have been Shipton's and Spargo's, on the northern edge, on tributary gullies draining down from Mount Walker. The water was first brought on to this ground some eighteen months ago by the Shipton Bros., the cost of construction of the race leading from the falls higher up the creek having been subsidised by the Government. The amount was all repaid within a few months of the commencement of sluicing, and since then this claim has proved very remunerative.

The high quality of the ore obtained in this locality is remarkable, a great quantity of light-coloured tin, some of it almost white in colour, being present. The flat presents features which point to its suitability for bucket dredging, and there seems to be every likelihood of its carry-

Plate VIII.



FLUMING IN DENSE SCRUB, ANNAN RIVER COY.'S RACE.

Plate IX.



**TIN-SAVING BOXES BELOW HYDRAULIC WORKING, ANNAN
RIVER COY., LESWELL.**

ing payable tin. A number of prospecting holes have been sunk at different places on the flat, exposing a rough bouldery wash at the bottom, and the results are reported to have been encouraging.

(2.) THE ANNAN RIVER COMPANY'S HYDRAULIC SLUICING WORKS.

This company has secured an area of about 80 acres of residual deposits at the head of Baird's Creek, flowing into the Annan, and another 150 acres across the divide about the sources of Jones Creek, which flows into Wallaby Creek above Rossville. Hydraulic sluicing has been commenced on the former piece of ground known as the Leswell Lease, which lies immediately below the old Leswell Mines. The ground consists of detritus lying on the hillside, where the slope has been sufficiently flat to allow of its accumulation. Much of the tin contents have no doubt been derived from the disintegration of the veins of ore worked in the old Leswell Mines and other veins of similar character.

The compact nature of the ground to be worked and the mass of boulders and stones of all sizes to be dealt with are proving a source of considerable trouble. During the first seven weeks about 8,000 cubic yards of material were shifted, and gave a return of $5\frac{1}{4}$ tons of tin. It is hoped that as things are got into better working order greater progress will be made.

The water for sluicing operations is brought from one of the heads of Parrot Creek, a distance of about seven miles, through very rough scrub covered country, where the character of the ground necessitated the construction of a considerable amount of fluming.

Plate VII. gives a picture of the dam and sluice gate, by means of which the water of the creek is turned into the race; while Plate VIII. is a picture of part of the fluming. The nozzles are worked under a pressure of 240 ft., and the race has sufficient capacity to keep two 2-in. nozzles working when running half full.

The leases on the Collingwood side have so far not been tried. I understand that the prospects in this ground are also very encouraging. Plate IX. gives a picture of the sluices-boxes in which the tin is saved, and shows in the background a portion of the ground already worked. An idea of the character of the ground to be dealt with may be gathered from Plate V.

(3.) WALLABY CREEK.

Native YOUTH and Hatfield's Claims, Rossville.

These claims lie near the junction of Jones Creek with Wallaby Creek. Immediately opposite the Rossville Public House, Wallaby Creek flows over a bar of granite, above which the creek and its numerous tributaries draining down from the Collingwood Range and the Bald Pocket have deposited a wide stretch of scrub-covered

alluvium. The boundaries of this ground are roughly indicated by the area shown on the map as having been taken up in dredging claims. This area narrows as the main creek is ascended, but extends up beyond the junction with Slaty Creek, a distance of about three miles above Rossville.

The granite bar was cut through in 1892 by a channel 7 ft. deep and 8 ft. wide, and for a length along the bed of the creek of about eight chains. This work, by reducing the level of the water in the creek bed, has allowed of the working of the gravels underlying the alluvial ground higher up to a correspondingly greater depth. Even now, however, there are deeper holes which have to be bailed during the dry seasons to allow of the gravel being lifted into the ground sluices. The depth of alluvium in these claims runs up to nearly 20 ft., and involves the use of a correspondingly great amount of water to remove the overlying poorer drift before the wash can be treated.

Plate X. gives a view of the Native Youth claim, on Wallaby Creek, while Plate XI. gives a picture of Hatfield's claim on Jones Creek, immediately above its junction with Wallaby Creek. The country surrounding and lying above these claims has been taken up with a view of working it by more economical methods. In 1898 an attempt was made to dredge the ground immediately above the bar, but, from causes explained before, this project was a failure. The depth of alluvium and the numerous boulders to be dealt with, as well as the liability of this locality to destructive floods, against which it will be extremely difficult to protect any form of floating dredge, seem to point to the necessity for some more manageable method of attacking the problem. Probably some form of hydraulicking the face would be most suitable. In this case, however, the enormous amount of tailings to be got rid of and the want of sufficient fall would have to be considered, and would probably necessitate the elevating of the material to be washed, by some form of suction pump, to a considerable height above the bed of the creek.

Kerr Brothers and Yateman's Claims.

These claims are situated on the spurs of the ridges between Jones and Byers Creeks and have been among the best claims in the district. The ground lies well above the present level of Jones Creek, and is apparently the result of a former system of drainage when the bed of Wallaby Creek was at a considerably higher level than it is at present. As the bed of Jones Creek became eroded back by cascades and falls to its present depth these alluvial terraces would appear to have been left at the higher level. They have subsequently been cut into by cross channels of drainage coming down the hillsides till they are now found occupying the points of the spurs between these water-courses.

Plate X.



NATIVE YOUTH CLAIM, WALLABY CREEK, ANNAN RIVER.

Plate XI.



HATFIELD'S CLAIM, WALLABY CREEK, ANNAN RIVER.

Plate XII. is a picture of Yateman's claim, showing a depth of face of about 15 ft. in the middle, the surface of the wash sloping away on either side towards the present water-courses. The floor of the wash meanwhile presents a gentle slope towards the right in the direction of that of the drainage, by which it was left behind. This claim has been worked up from the point of the spur for about 150 ft., but the ground is now beginning to rise rapidly and the edge of the rock bed on which the alluvium was laid is found cropping out a few yards further up the hill.

Kerr's upper workings on the adjoining ridge show the same general features.

The Home Rule Claim.

This claim lies on a branch of Wallaby Creek about a mile and a-half above Rossville, in dense scrub, and has only been opened out within recent years, during which time it has proved very remunerative to the three owners. The face here is about 12 ft. in height, and the comparatively large amount of fall has allowed of very economical working. The water is brought in from above the Home Rule Falls, on Slaty Creek (a picture of which is given on Plate I.), a distance of about a mile. Some of the fluming for this race had to be built round the face of a perpendicular cliff, the men engaged in the work having to be swung over the edge of the cliff by ropes in order to allow of supports being driven into the rock to carry the fluming.

The claim has recently been acquired by an Adelaide company, which proposes to hydraulic the ground under pressure, for which they should apparently have sufficient height and volume in the supply already available. Plates XIII. and XIV. give a representation of the character of ground in the Home Rule claim.

About 700 acres of ground have been taken up as dredging claims on either side of Wallaby Creek, running for a distance of about a mile above Rossville, and embracing the flats on either side. This ground has, I understand, recently been thoroughly prospected by numerous bore holes, but I have not been able to learn in detail what results were obtained.

Dick and Coutts's Claim.

This is an area of creek wash lying on the old Bloomfield track about three miles from Rossville, a tributary of Wallaby Creek. The ground is about 10 acres in extent, and through it the creek winds in a tortuous course, the alluvial ground being hemmed in by steep banks on either side. The alluvium is held up by a bar of granite, which has allowed of the corrasion of the banks of the stream above it, and the consequent deposition of wash and alluvium in its bends. The ground has been worked here and there in pockets, whenever the season has been dry enough to allow of the wash being reached. Good tin is

reported to have been got. The present owners are cutting a channel through the granite bar, by which they hope to lower the water some 7 or 8 ft., and thus reduce the level of the water in the ground above. They then propose to bring in a race from higher up the creek, and either ground sluice or hydraulic the ground.

(4.) TABLELAND AND MOUNT AMOS.

The Tableland workings are situated along the source of Mungumby Creek, which flows due west from here to join the Annan River near Helenvale Public House, the workings being about four miles due east of the junction. The pack track goes up the creek flats from the public house for about two miles, and then rises rapidly to a height of about 1,700 ft. above the sea. The workings are scattered along the upper course of the main creek, and on numerous gullies draining into it from the south. At present the only work being carried on is along the main creek, which has been worked by ordinary ground sluicing for a length of about a quarter of a mile.

This ground occurs above a bar of rocks, over which the creek runs in a series of cascades and falls for about another mile, till it plunges at the Falls into the valley below. About 180 acres of thick scrub land, lying along the sources of numerous gullies to the south of these workings have been taken up as the Adelaide and Bower Bird Dredging claims, with the intention of installing a hydraulic sluicing plant to economically treat the poorer material left along the gullies by the early fossickers and the surface soil. The water will have to be pumped from a dam on the main creek, but the shallowness of the overburden and splendid facilities for disposing of the tailings, owing to the rapid fall of the ground to the west of the tin-bearing ground, should allow of very economical treatment.

In the lower valley of Mungumby Creek, below the Tableland workings are wide flats of alluvial ground which apparently have not yet been prospected. They show from their position below good ground every probability of carrying tin, but the level character of the ground on which they lie has probably proved an obstacle to their being successfully dealt with by ordinary ground sluicing.

At Mount Amos numerous stretches of good alluvial ground lie along the lower slopes of the mountain, in positions eminently suitable for ordinary ground sluicing. Owing, however, to the proximity of the ground to the sources of drainage, the supply of water fails comparatively early in the year.

The best claim is Archbold's, situated on the site of the old township, this claim having been worked continuously since the first discovery of tin in the district. The ground worked here occurs as an elevated terrace on the southern bank of Waterfall Creek, which falls into the sea about a mile further north. Perhaps a quarter of an acre of ground has been worked out here, the face at the top end of the

Plate XII.



OLD ALLUVIAL IN YATEMAN'S CLAIM, NEAR ROSSVILLE.
SHOWING FALL OF SURFACE ON EITHER SIDE OF RIDGE.

Plate XIII.



WORKINGS ON HOME RULE TIN CLAIM.

Plate XIV.



WORKINGS ON HOME RULE TIN CLAIM.

ground being some 12 ft. in depth and carrying numerous boulders and stones. Below this ground, bordering the present bed of the stream, is an area of alluvium of a lower terrace, to which attention is now being turned, and which is proving remunerative.

VII. CONCLUSION.

It will be seen from the above account, and from a glance at the accompanying map, that rich alluvial tin occurs at numerous points over an area of country some twelve miles in length by eight miles in breadth, its boundaries conforming roughly with those of the intrusive granites. These alluvial deposits have been worked hitherto mainly without the employment of any engineering skill except that incidental to the construction of races and fluming to bring water in from some higher source over the face of the material to be dealt with. Of late years, however, piping has been employed in one or two instances to carry the water over intervening depressions, and hydraulicing the face with water under pressure has been resorted to. In one case only up till within quite recently has any attempt been made to deal with the alluvial deposits by machinery by dredging the alluvial flats above Rossville, this attempt having been rendered abortive by want of knowledge of the difficulties of saving the tin and by the destruction of the dredge by floods.

Within the last year one elaborate scheme for treating the alluvial deposits on a more extensive scale has been completed at Leswell, and is working more or less satisfactorily, while two other schemes—that at the Home Rule claim on Wallaby Creek, and that on the Adelaide and Bower Bird leases on the Tableland—are in a fair way to commence work, the machinery having already been landed at Cooktown. Other areas in the immediate neighbourhood of the present workings show prospects of becoming remunerative with the adoption of more economical methods of working.

The creeks on which these workings lie all drain westward into the Annan River. Besides the deposits lying along them, and already more or less proved by numerous workings, some 1,000 acres of alluvial flats extending for 15 miles along the Annan River itself have been taken up. Apparently no attempt has been made to prospect these flats, but their position holds out every prospect of their carrying good tin. Their possibilities in this respect were pointed out by Dr. Jack in his report issued in 1891 after a visit to the field. The engineering difficulties connected with the treatment of this ground may be considerable, but they do not seem to be more formidable than those already overcome in other parts of the world.

Brisbane, 28th October, 1906.



NOTE- Areas surveyed as Dredging Claims shown in Red

20739

Queensland.

DEPARTMENT OF MINES.

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PUBLICATION No. 311.

STANHILLS TINFIELDS.
(NEAR CROYDON.)

[WITH TWO PLANS AND THREE PHOTOGRAPHS.]

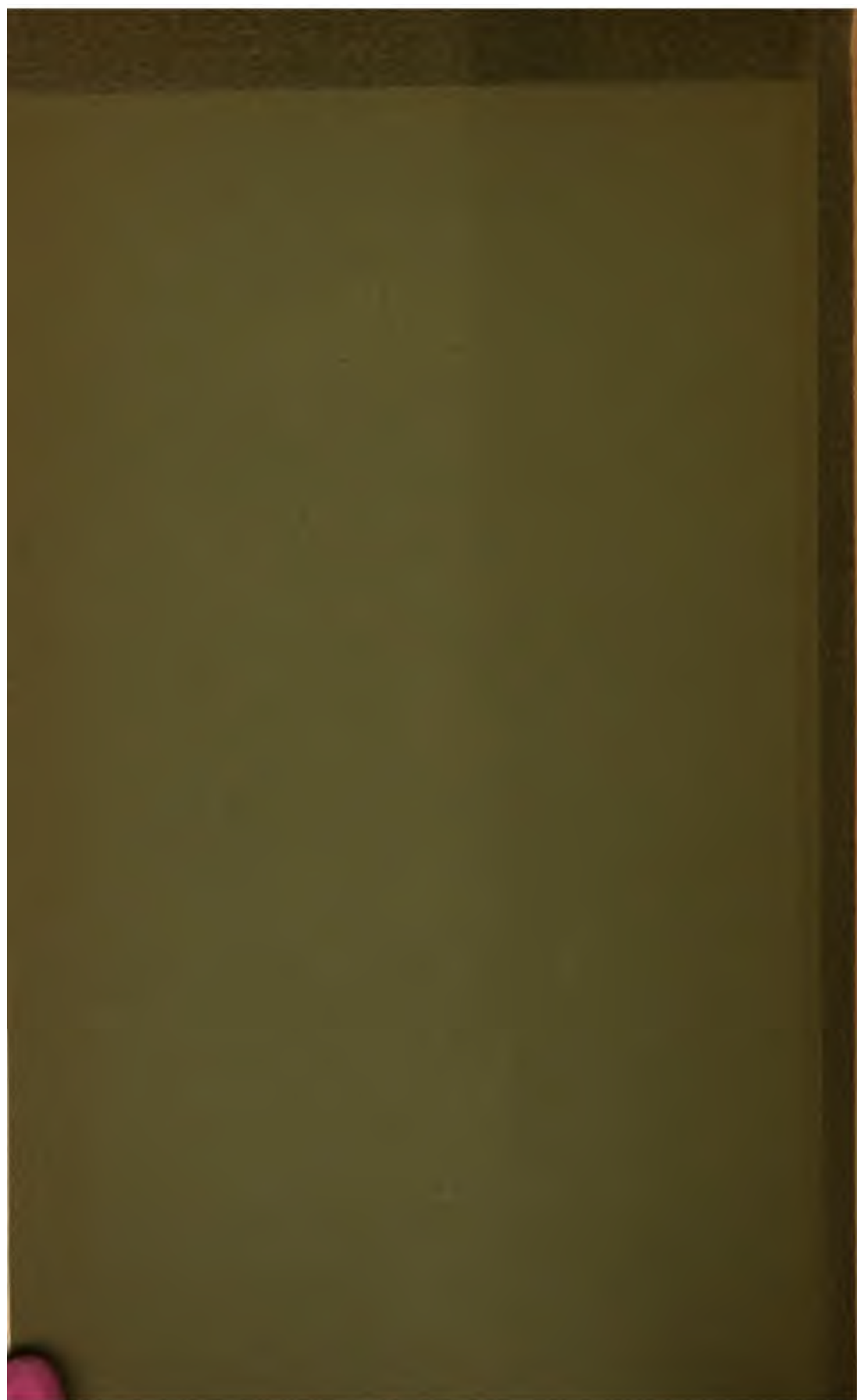
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ACTING GOVERNMENT GEOLOGIST.



BRISBANE:

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1907.



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ACTING GOVERNMENT GEOLOGIST.



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Stanhills Tinfields.

(NEAR CROYDON.)

GENERAL FEATURES.

Stanhills, the name given to a tinfield situated between twelve and twenty-four miles to the south-east of Croydon, on the Croydon-Esmeralda Road, was at one time considered to have a very promising future, but subsequent developments failed to realize the expectations of those interested in the matter, and, in consequence, the field was abandoned. More recent operations, however, have revealed ore of exceptionally rich quality, and again the field has become very active.

The north-eastern edge of the field lies close to the Alluvial Springs at Moonlight Creek, about twelve miles south-east of Croydon, where the tin is found in an alluvial deposit associated with Desert Sandstone, the other end of the field being about twenty-four miles in the same direction from Croydon. North and south of the Esmeralda Road (*see* Plate 1) the tin is found either in a lode formation or in alluvial deposits, and the area of the whole field, so far as recent discoveries have indicated, is about one hundred square miles.

GEOLOGICAL FORMATIONS.

In travelling from Croydon to Stanhills, granite is first seen at Moonlight Creek, and is observed to continue through a defile known as the Bucket Gap, where it is covered on either side with thick beds of Desert Sandstone. From the gap the granite extends all along the route to the tinfields, but with numerous alternations of masses of quartz-felsite, aplite, and chlorite.

The Desert Sandstone forms isolated flat-topped hills in the granite country, and are conspicuous features in every part of the tinfield. At the Black Springs, about a mile from the Esmeralda Road (*see* Plate 1) it is, itself, tin-bearing in places, as well as forming a capping to tin-bearing granite.

At Pharaoh's Falls, on Nundah Creek (*see* Plates 4 and 5), the sandstones form the lower edges of a horizontally-bedded series, resting on granite and quartz-felsite at the base of the Gregory Range. There are here several interesting geological sections exposed in the cliffs, and after a spell of dry weather, when all sediment adhering

to the rocks are removed, the cliffs are seen to be fantastically marked with red-and-white colouring, and the Egyptian appearance produced by these markings has suggested the name given to the Falls.

The rocks are tuffaceous sandstones, and were originally of a uniform reddish colour, but along the joint planes the colouring matter has been leached out by water, leaving the rocks white in the vicinity of the joints, and reddish some few inches away.

MINES.

The principal lode-tin deposit is that at the *Brilliant P.C. Mine*, the position of which is shown on the accompanying plans (Plates 1 and 2). The country in this locality is composed of altered granite(?), aplite, and quartz-felsite, the tinstone being distributed irregularly through chlorite mixed with quartz and greisen. No definite trend of the ore-body up to the present has been distinguished, although surface and underground indications show a general east-and-west strike.

The minerals associated with the tinstone are copper and iron pyrites, galena, and zinc blende, the copper pyrites occurring only in traces, the other minerals to the extent of a few per cent.

The workings are situated near the centre of the lease, and consist of two shafts and two cross-cuts. No. 1 Shaft is over fifty feet deep, but, being filled up to that level with mullock, the actual depth could not be determined at the time of the examination. No. 2 Shaft is also fifty feet deep, from the bottom of which a cross-cut connects it with No. 1 Shaft. From No. 1 Shaft this cross-cut was driven a distance of fifteen feet, in the direction E.N.E., and was then turned northerly to meet No. 2 Shaft. The second cross-cut has been driven E.N.E. from No. 1 Shaft at a depth of thirty feet from the surface, the length being twenty feet.

Some of the stone taken from the lode is exceedingly rich, and several tons of thirty-per-cent. ore at the time of the inspection was stacked on the surface. The portion of the unbroken lode, as exposed in the workings, contains up to one per cent. of tin, mixed in places with zinc blende and iron pyrites, but at the bottom of No. 1 Shaft the lode, while poor, gives promise of developing into the same class of rich stone that was found in the shaft nearer the surface.

Trenches have been made around No. 1 Shaft, and have exposed some large specimens of rich ore, but the other portions of the lode, exposed in the same workings, show only traces of tin.

There is every probability of rich and poor bodies of ore alternating with one another, although at present no order can be seen as to how these bodies occur. It is impossible, therefore, to state

definitely in what direction operations should be extended, except to advise that the ore be followed along its probably east-and-west course, and to be prepared to find very rich bunches of ore in very poor country.

About ten chains to the north-east of the above main workings, a trench seventy feet long has been made in a tin-bearing aplite dyke contained in altered granite country. A flat deposit of tin ore, about two feet thick, was discovered in one part of the trench, and the mineral therein shown indicates that further work should be expended upon it. A smaller vein of similar quality stone, about two inches thick, is also exposed in the trench.

The position of these workings is shown on Plate 2, and the battery returns from the crushed ore are given in a table further on.

The old claim, *Brilliant No. 1*, is situated to the east of the Brilliant P.C. Mine, the workings consisting simply of a trench in which a vein of rich tin ore has been exposed. The country is granite and felsite, the lode being composed of chlorite and aplite, but the vein of ore in the trench pinched out after being followed for a few feet.

The *Ivanhoe Mine*, now included in the Brilliant North Lease, is located about eighteen chains to the north of the Brilliant P.C. workings. A shaft has been sunk to a depth of forty feet, in both coarse and fine-grained granite, quartz-felsite, and chlorite; the tin ore, it is said, showing in small veins in the granite and chlorite. At a depth of sixteen feet from the surface the veins have been cut off horizontally, and further sinking did not result in anything being discovered. Stone raised from this shaft amounted to several tons, having an estimated yield of about four per cent. of tin, and containing traces of galena.

In the bed of the creek, close to the shaft, a chlorite lode containing a quartz vein is exposed between granite and felsite walls, both the chlorite and quartz being tin-bearing. The lode has not been prospected, although it can be traced along the surface for about eighty feet, and no idea could be gained of its character or value. It appears to be very rich, however, being studded with tin crystals (cassiterite) in places, and as it may have some connection with the lode worked in the shaft, it certainly should not be neglected when prospecting operations are taken in hand.

The position of the Ivanhoe workings is shown on Plate 2.

The *New Chum Mine*, also included in the Brilliant North Lease, lies ten chains south-west of the Ivanhoe, and fifteen chains west of the Brilliant P.C. Shafts (see Plan 2), the workings consisting of some excavations and a shaft in chlorite and felsite, with granite on either side. The latter rock is alternately fine and coarse in texture,

and appears to be in the form of dykes in felsite, the tin occurring as small but rich veins and irregular masses throughout the formation. The felsite contains rounded blebs of graphite, and a decomposed granite in the vicinity contains vermiculite mica.

A few yards westerly from the excavations a shaft has been sunk to a depth of twenty-eight feet, the lode here being made up of chlorite and quartzite, and associated with felsite and granite. The tin taken out is said to have occurred as small rich veins.

The Koh-i-nor Mine lies on the top of a ridge about a mile to the north-east of the Brilliant P.C. Mines. The country is quartz-felsite, and the tin occurs in a quartz vein, varying in thickness from five inches down to a mere thread, a vein of almost pure tinstone, two inches thick, being exposed in the workings. Two shafts have been sunk, each to a depth of about forty feet, and about sixty feet apart, and a trench twenty feet long has also been excavated, but the ore body exposed in these workings gradually becomes smaller, and as it is followed down it pinches out altogether.

On the road to the Springs, a few chains easterly from the Koh-i-nor, a chlorite lode has been prospected, and several tons of stone from here is said to have yielded nine per cent. of clean ore by crushing and concentration.

Furbur and White's Homestead Claim is situated about a mile northerly from the Koh-i-nor, and is surrounded by hills capped with "Desert Sandstone." On this property a chlorite lode has been exposed for some distance, and the prospecting work carried out on it, although very limited, has been sufficient to indicate that it has an east-and-west trend, and is several feet wide. The chlorite is associated with aplite, neither granite nor felsite being found close to the workings, although present in the vicinity.

The yields of tin from the ore is said to average $3\frac{1}{2}$ per cent., but the value of the deposit, as a whole, has not yet been determined.

The Miner's Punch workings, now idle, are located on the northern side of the Ten-mile Creek, and are about three-quarters of a mile north-westerly from the Ivanhoe Shaft, and about a mile slightly north of this direction from the Brilliant P.C. Shafts. The country rocks are tourmaline-bearing granite and quartz-felsite, the former carrying a tin-bearing lode almost in contact with the latter. The trend of the lode is north and south, and this has been well shown in the trenches which have been made. The tinstone is contained in chlorite and quartzite, but although several tons of nine per cent. ore is stated to have been taken from the lode exposed in the workings, the mere traces of tin which now remain do not offer much encouragement to carry on further prospecting work.

The Comet Mines are on the north side of the Ten-mile Creek, close to the Esmeralda Road, and, in a direct line, are about two miles north-west from the Brilliant P.C. Mines (*see* Plates 1 and 2). The country for the most part is coarse-grained granite, this rock changing to a fine-grained granite and a dark-coloured quartzite, all being in close association with a pipe-like mass of chlorite and with irregular bunches and small veins of quartz.

In the chlorite a shaft has been sunk to a depth of about sixty-five feet, exposing bodies of ore made up of tinstone, galena, zinc blende, and copper pyrites, with copper carbonates near the surface. All of these minerals are in the chlorite, although most of the tinstone occurs quite free from the other minerals. The quantity of ore taken from the shaft is said to amount to 233 tons, as shown in the battery returns on page 12, the yields from which amounted from five to ten per cent. of tin. Some of this stone, however, may have been taken from other mines in the neighbourhood and included in the Comet returns, but the quantity from this source would not amount to many tons.

About 400 feet north from the Comet Mine, a sixteen-foot shaft has been sunk in chlorite, the general conditions being somewhat similar to those prevailing at that mine, except that the chlorite lode is associated with a quartz blow. No yields of tin are reported from this mine.

To the south of the Comet shaft a chlorite lode, three feet thick, is exposed within granite walls, this rock merging into aplite and pegmatite. Tin ore has been removed from the outcrop of this lode.

The Douglas Mine is located on the Ten-mile Creek, about five miles westerly from the Comet, and about the same distance south of Flanagan's Homestead Lease (*see* Plate 1). The country rocks are granite and greisen, in which there exists a four-foot lode of tin-bearing chlorite, having approximately an east-and-west strike, and exposed for a distance of about one hundred yards. A shaft has been sunk on the lode to a depth of fifty feet, but no information could be gleaned concerning it, further than that several tons of good ore were taken away and that the mine was grossly mismanaged.

Kellaway's Claim is about a quarter of a mile north of the Douglas Mine (*see* Plate 1). The lode is made up of chlorite and greisen, has an east-and-west strike, is about four feet wide, and is contained between granite walls. Six inches of the lode is said to be rich, but no authentic information is obtainable.

Foley's Mine lies about one and a-half miles west of the Comet Mines, and about the same distance south from the junction of Rocky Creek and Ten-mile Creek. There are two tin-bearing forma-

tions present in the workings, each thirty feet wide, and they are in felsite. No information is available concerning the results of prospecting operations.

Wheeler's Claim is situated about five miles to the south of the Comet Mines (see Plate 1). A lode of irregular shape, and consisting of chlorite, quartz, and greisen is exposed between granite and quartz-felsite, and has been worked in an open-cut to a depth of about ten feet. Seven tons of stone has been removed from the lode, and is said to have given a return of eight per cent. of tin.

Flanagan's Claim is located on Mistake Creek, less than a mile west of the crossing of the Esmeralda Road. The country is granite, with occasional outcrops of quartz-felsite and greisen. The tinstone occurs irregularly in the greisen, both quartz and chlorite being absent. The prospecting work consists of some shallow excavations in the greisen, but is not sufficient to prove the extent or character of the deposit.

There is a large area of tin-bearing country exposed in this locality, which might carry sufficient tin to make portions of it a low-grade proposition. In view of this possibility, it might be advisable to prospect the tin-bearing outcrops in the neighbourhood, and also those to the north-west towards Furbur and White's Claim, the latter probably being part of one long continuous belt extending to Flanagan's Mine.

Other localities have been reported to contain tin-bearing lodes, one in particular being about fifteen miles west of the Brilliant Mines. If this information be correct, the area of the Stanhills tinfield would be considerably extended. Another locality mentioned is about eight miles northerly from the mill on Lease 2051 (see Plate 1), and Mr. C. F. Valentine reported it to be "a chloritic outcrop which has fairly big possibilities." It is said to consist of two formations, each made up of quartz and chlorite, the larger of which is ten feet wide.

ALLUVIAL DEPOSITS.

Very little stream tin had been found up to the time of the inspection of the tinfield by the writer, but recently some very rich patches of washdirt have been discovered near the Brilliant Group of mines, and attention has in consequence been drawn to the general occurrence of the tin in the alluvial deposits throughout the district.

On the branch of *Ten-mile Creek*, between the Miner's Punch and Furbur's Old Homestead Claim, there is an alluvial formation of about half a mile square in area, which may contain deposits of stream tin, while there are hosts of other localities about the heads of the Ten-mile Creek and other watercourses in this direction which

might also be found ultimately to be tin-bearing, each, perhaps, limited in extent, but probably rich.

At the locality called the *Black Springs Waterhole*, on Locket Creek, situated about one and a-half miles east of Flanagan's Homestead Lease (*see* Plate 1) there are shallow alluvial deposits containing tin and gold, but there has not been sufficient development to prove their extent, or to show their connection with the beds of "Desert Sandstone" which form the ridges to the west of the waterhole, and which are themselves tin-bearing. The surface deposits here are undoubtedly rich in places, and in the wet seasons have been worked very profitably both for tin and gold—principally the latter—and they certainly deserve further attention. The "Desert Sandstone" comprises hard beds of tin-bearing sandstone, several feet thick, but it has not been prospected, and its possibilities are yet unknown.

If the area of tin and gold-bearing country were proved to be extensive, and warranted developments on a large scale, water could be conserved in dams, or could be supplied by pumping from the permanent supply at the Black Butt Springs, about one and a-half miles south of the Black Springs Waterhole.

At the *Alluvial Springs*, about five miles to the north-west of the Black Springs, and about three miles from the Bucket Gap (*see* Plate 1), an alluvial deposit of tin was discovered many years ago in the "Desert Sandstone," but, after being prospected and tested, the yields of tin obtained were not then considered satisfactory, and the mine was abandoned.

PROSPECTS OF THE FIELD.

At the time of the inspection the Brilliant P.C. Mine was being developed, and some very rich ore had just been taken from the workings. Since then the Brilliant Mine has continued to produce high-grade stone near the surface, whilst in the watercourses in the neighbourhood, and at some distance away, many tons of stream tin have recently been found (*see* Plates 1 and 2).

A large number of men are now working the alluvial deposits, and no doubt employment will be found for the miners for some time to come. Very rich patches of washdirt are bound to be found in the gullies, but, with the absence of extensive alluvial deposits (the contour of the country being adverse to the formation of deep leads), there is hardly any probability of the field becoming an alluvial one of any great importance. On the other hand, the tin-lodes deserve attention, and amongst the number which have only been cursorily tried there are some which, on development, might prove to be of great extent and richness.

STANHILLS TIN RETURNS.

	Tin Ore.				Black Tin.				Value.		
	T.	C.	Q.	LB.	T.	C.	Q.	LB.	£	s.	d.
BRILLIANT P.C. LEASE.											
1900—Sent to Sydney (Dapto) ...	3	1	3	14	1	7	2	3	99	12	6
1900—Sent to Sydney (Dapto) ...	3	12	1	25	1	3	0	21	92	9	2
1902—Sent to Sydney (Dapto) ...	1	10	1	8	0	11	3	25	37	2	6
1904—Treated at Rocky Mill ...	78	0	0	0	4	5	0	14	229	16	9
1905—Sent to Sydney (Dapto) ...	2	16	0	9	0	18	3	21	81	0	0
Total	89	0	3	0	8	6	3	0	£540	0	11

COMET LEASE.

1900—Sent to Sydney (Dapto) ...	3	4	1	12	0	14	2	17	57	19	8
1901—Sent to Sydney (Dapto) ...	30	0	0	0	3	5	0	0	126	10	0
1902—Crushed at Rocky Mill ...	50	0	0	0	5	0	0	0	250	0	0
1903—Crushed at Rocky Mill ...	10	0	0	0	1	0	0	0	50	0	0
1904—Crushed at Rocky Mill ...	80	0	0	0	6	10	0	0	377	0	0
1904—Crushed at Rocky Mill (seconds) ...	60	0	0	0	2	4	0	0	118	16	0
Total	233	4	1	12	18	13	2	17	£990	5	8

PLATE 1.

SKETCH PLAN (UNSURVEYED) OF STANHILLS TINFIELDS.

The information contained on this plan has been compiled from several sources, but mostly from data supplied by Mr. Charles Furbur, who, as a prospector, has become thoroughly acquainted with this part of the country.

The topographical features have not been surveyed, so that the position of the creeks, lagoons, springs, &c., are given very roughly. Except the Comet and Brilliant Mines, which have been surveyed, the positions of all the tin-mining centres are also given approximately.

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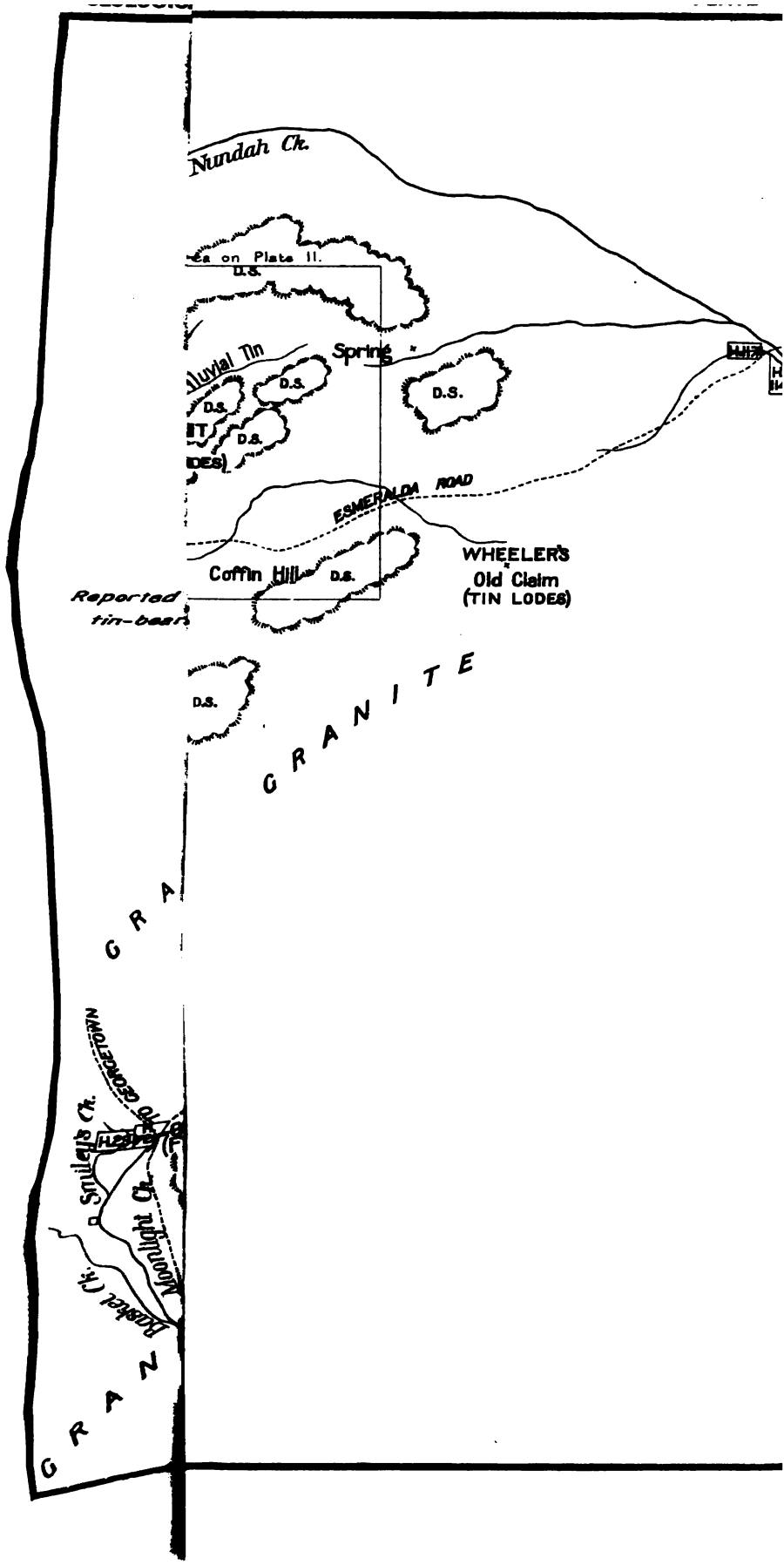


PLATE 2.

GEOGRAPHICAL SKETCH PLAN OF PORTION OF THE STANHILLS TINFIELDS.

The work of accumulating the information for this plan was carried out very rapidly, so that the geological features shown are only approximately correct.

The alluvium, as a deposit of any extent, is only seen in one locality, but there are many other places where tin deposits exist in small areas, which, however, are often very richly tin-bearing.

The "Desert Sandstone" forms the caps of most of the granite hills around the tinfields, and is sometimes tin-bearing. They are evidently formed from tin-bearing granites, which once existed at higher levels, but which have since then been worn down to their present level.

The Quartz Felsite and Granite occur irregularly associated with one another, changing gradually into one another and into greisen. The contact between the two former rocks in the vicinity of the Brilliant Mines is not defined, and the geological lines are here subject to revision.

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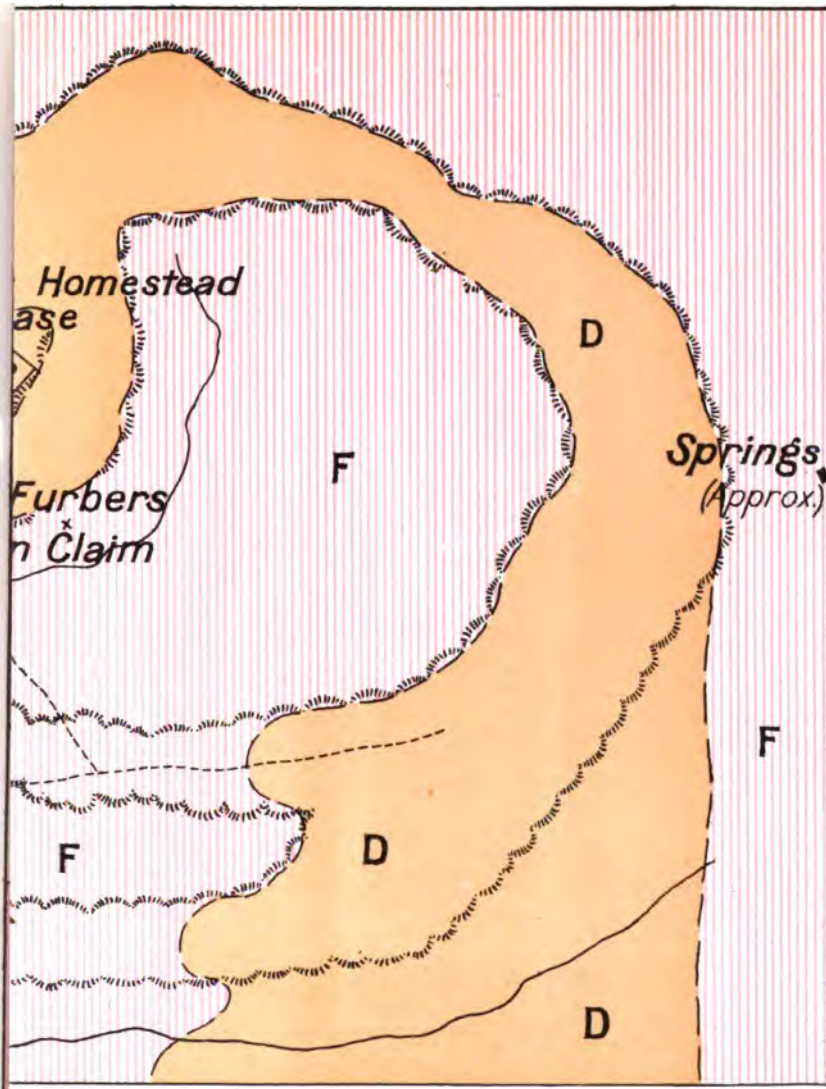
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GEOLOGICAL SKETCH MAP
of portion of the
STANHILLS TINFIELD
NEAR CROYDON
Accompanying Report
BY
B. DUNSTAN, F. G. S.
Acting Government Geologist
1907.

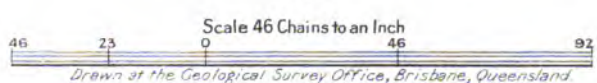


PLATE 3.

PHOTOGRAPH OF THE BRILLIANT P.C. TIN MINE, STANHILLS TINFIELDS.

The blocks of stone in the foreground are very rich tin ore, a specimen in the Geological Museum from this mine assaying 34 per cent. of tin, and weighing one and a-half hundredweights.

The excavations shown in the view have been sunk for the purpose of following the rich body of ore traced along the surface by Mr. C. Furbur, but since the photograph was taken this work has been much extended. Some large slugs of pure tin ore were found on the surface, to the left of the view, and this led to the prospecting work which revealed the tin-ore *in situ*.



PLATE 3.—BRILLIANT P. C. TIN MINE, STANHILLS TINFIELD.

PLATE 4.

PHOTOGRAPH OF PHARAON'S FALLS, NUNDAH CREEK, STANHILLS.

The cliffs are composed of beds of "Desert Sandstone," with an underlying stratum of clay. The weathering out of this clay, by atmospheric agencies, combined with the vertical joints in the rocks, cause the breaking down of the beds, and thus the formation of the cliffs.



PLATE 4.—PHARAOH'S FALLS, NUNDAH CREEK, STANHILLS.

PLATE 5.

PHOTOGRAPH OF PHARAOH'S FALLS, SHOWING CLEOPATRA'S BASIN.

The two large blocks of stone in the centre of the view have been broken down from the bed on the left side by the action of flood water. The dark pool at the back of the displaced block is called "Cleopatra's" basin, and the water coming into this from the fluted channel above during a storm makes a sound which can be heard for miles.



PLATE 5.—PHAROAH'S FALLS. VIEW SHOWING CLEOPATRA'S BASIN.

10739

Queensland

DEPARTMENT OF MINES

Queensland Geological Survey

(B. Dunstan, Acting Director-General)

PUBLICATION No. 218

SOUND

CROYDON GOLD MINES

(Part 2)

WITH SPECIAL REFERENCE TO MINERALS, ROCKS AND
GOLD-BEARING VEINS.

(WITH TEN PLATES)

BY B. DUNSTAN, F.R.S.

ACTING DIRECTOR-GENERAL



PRINTED BY THE GOVERNMENT PRINTER, QUEENSLAND



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(B. DUNSTAN, ACTING GOVERNMENT GEOLOGIST.)

PUBLICATION No. 212.

SOME

CROYDON GOLD MINES
(Part 2),

WITH SPECIAL REFERENCE TO BENNION'S REEF AND
THE HIGHLAND MARY REEF.

[WITH TEN PLATES.]

By **B. DUNSTAN, F.G.S.,**
ACTING GOVERNMENT GEOLOGIST.



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1907.

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SOME CROYDON GOLD MINES.

**With Special Reference to Bennion's Reef and the
Highland Mary Reef.**

INTRODUCTION.

The Highland Mary Reef, close to the town of Croydon, produced some very rich yields of gold many years ago, and on account of the recent failure in the prospecting developments in many of the mines at Croydon causing a general depression in the local mining industry, some attention has lately been given to this once important line of reef, with a view of having it reopened and worked again.

A visit was paid to Croydon in July, 1906, for the purpose of obtaining data bearing on the old workings of the above reef, and also to inspect the recent developments in Bennion's Mine. A reef has been found in the latter mine which, it is thought, might have some connection with the Lady Mary and other reefs that once yielded a large amount of gold close to the surface.

THE HIGHLAND MARY REEF.

The accompanying sketch plan (Plate 2) shows the position of the two sites on the Highland Mary reef, where it has been suggested operations should be commenced, the site marked "A" being that of the proposed deep shaft, 600 ft. away from the outcrop; the other, marked "B," being the site of a shaft already sunk, where it is thought a reef exists which might be worked on the underlie.

After examining the surface features about the outcrop of the Highland Mary Reef, and noting all the information which has been accumulated bearing on the past history of the mining developments in this locality, one comes to the opinion that the sinking of the "A" shaft, 600 yards away from the outcrop, is far too hazardous to warrant the expenditure of money on it until some further developments have taken place nearer the outcrop.

The other proposition, to sink an underlie shaft, "B," from the No. 1 South Block shaft, required some consideration, as the shaft is said to be sunk to a well-defined reef. Some of the old miners, however, are of the opinion that in these workings the only reef existing is a vertical one quite distinct from the Highland Mary, and Mr. J. Bickerton, who claims to have been the last man to work in this mine, states positively that there is no reef down in the underlie at the bottom of the straight shaft. Since examining the field the

departmental records of the three bores which were sunk on the Highland Mary reef during the years 1890 and 1891 have been examined, and these throw some further light on the subject.

The bore known as No. 1 is situated on the Highland Mary No. 1 South Block, and is marked "C" on the accompanying plan. It was started on the 2nd July, 1890 (Foreman Elliott in charge), and after boring to a depth of 490 feet, the rods broke, and work, on 17th January, 1891, was discontinued. At 182 feet, crushed granite was passed through; and at 243 feet blue granite, containing graphite, was met with. At 368 feet, two veins of quartz occur, each one quarter of an inch thick; and, at 371 feet, several vertical quartz leaders were passed through, varying in thickness up to one quarter of an inch, and contained in hard blue granite. In this bore there is nothing to indicate that the reef was passed through, although it is quite possible that the reef may be present, and that the bore has passed through a "blank" without showing any indication of its presence. (These blank areas are common in the Golden Gate Reef.)

No. 2 bore, marked "D" on Plate 2, is situated on the Highland Mary No. 1 Block Claim, and was started on 7th February, 1891, reaching a depth of 267 feet on the 16th May of the same year. At 204 feet hard but broken "spar" was passed through, and at 219 feet granite containing graphite was met with, 13 feet of this being penetrated, and at the bottom graphite also occurred in a grey granite. This bore also was disappointing, and gave no signs of a reef further than what the "spar" at 204 feet and the graphite at 219 feet might indicate.

No. 3 bore was sunk close to the Glengarry Mine, marked "E" on Plate 2, and started operations on the 15th June, 1891. A depth of 266 feet was reached, and the work ceased on the 17th October, 1891. At a depth of 72 feet a hard slaty rock was passed through, more of the same material being met with at 92 feet. At 93 feet a band of broken rock was encountered, and at 102 feet a rock, described as "red conglomerate," was passed through, this formation being over 10 feet thick. At 103 feet a band of serpentinous rock was struck, but below this nothing but hard granite was found, except plumbago in blue granite at 266 feet, where the boring operations stopped.

The information from these bores goes to show that the reef has not been found at the depth expected, and confirms Mr. Bickerton's positive assertion that there is no reef which could possibly be the Highland Mary Reef in the workings of the No. 1 South Block Shaft.

Mr. Rands, who made a report on the Croydon Goldfield, states that the bores "were all sunk in hard intrusive granite," and were put down too close to the line on which the reef was lost. Had they been put down in the metamorphic granite, further to the north-east, the Highland Mary Reef would most probably have been discovered."*

* The Croydon Goldfield. W.H.R. Fep. (C.A. Paper). By Auth., Bris., 1896. [With 5 maps and 11 plates.] (G.S.Q.F., No. 118.)

To the west of No. 3 bore, in the Glengarry workings, according to Mr. Rands, a break or fault exists, and where the bore reached the depth at which the reef should have been found—that is, at about 200 ft.—no indication of a reef was to be seen; so evidently there is a break, or fault, between the bottom of the Glengarry workings and No. 3 bore.

At the bottom of No. 3 bore (266 feet), and at a depth of 219 feet in No. 1 bore, granite containing graphite was found, and with the evident westerly dip of the hard granite which has out off the reef in some of the workings, possibly this graphitic granite underlies, with a westerly dip, this hard granite. If this be so, then the conditions would be more favourable for prospecting to the east of the line of the three bores and the No. 1 South Block Shaft.

During the examination of the field the granite taken out of the Highland Mary Extended Block Shaft, marked “F” on accompanying plan, was inspected, and the conclusion drawn therefrom indicated that it has been sunk in graphitic granite, or what Mr. Rands has referred to as metamorphic granite, and that in consequence operations should begin in this shaft, and not the No. 1 South Block Shaft.

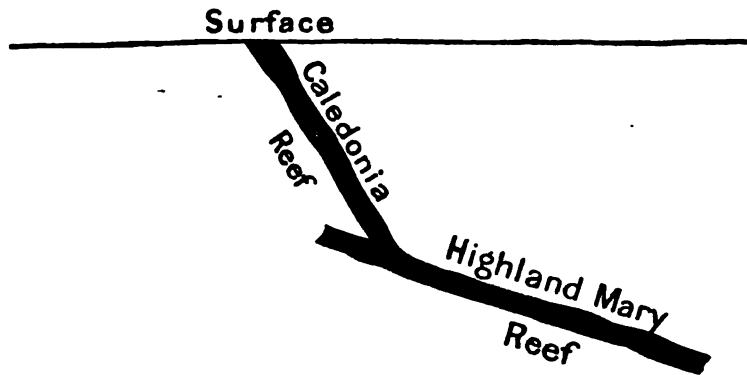
The sinking of a shaft at the position marked “A” has been estimated to cost £20,000, providing for a probable influx of water and other contingencies; while the cost of renovating the Highland Mary Extended Block Shaft, marked “F” on the plan, would not be more than £5,000. The latter position being found to be much more suitable when considered from all points of view, and the cost of sinking the shaft, both to the company and to the Department which has promised to subsidise it £1 for £1, being so much less than the first one selected, a recommendation was made to have it reopened and tested, in preference to sinking the “A” shaft and the reopening of the shaft at “B.” This being considered satisfactory to all concerned, the work of forming the company, under the title of the “Highland Mary Blocks, Limited,” was at once taken in hand, and the repairing and cleaning out of the shaft, prior to development, is now in progress.

It has been difficult to obtain any reliable data concerning the Highland Mary workings, but the information shown on the accompanying plans and sections (Plates 1 to 5) is fairly accurate, so far as it goes. A study of these will throw some light on the work performed in the past, and will also bear on that which has recently been taken in hand.

Some statements have been made by miners who at one time worked in the Highland Mary mines, and it is advisable that a record be kept of those which refer to the underground workings, so that in any work contemplated they may be brought into consideration. These are as follows:—

1. It is stated that the easterly dip of the Highland Mary Reef is flat near the Caledonia, but that where the reef turns and dips southerly the inclination becomes very steep, thus forming that portion known as the Caledonia. The severity of the movement which produced the bending also caused the reef to break and slide, one portion being thrust under the other, the upper steep portions being the Caledonia, the lower being the Highland Mary, as shown in Fig. 1.

FIG. 1.

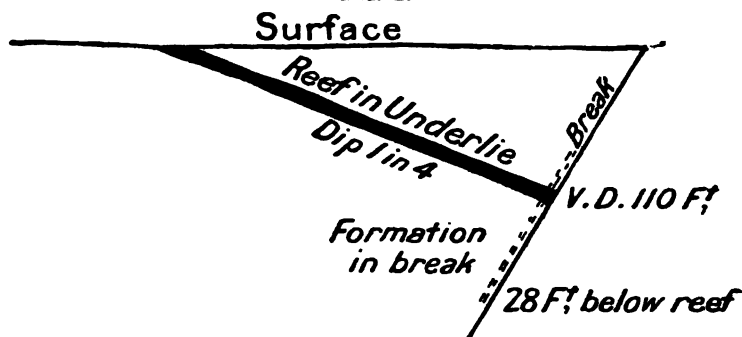


SECTION ACROSS THE HIGHLAND MARY LINE OF REEF.

Showing a thrust movement.

2. In the No. 1 North P.C. Highland Mary underlie the reef, according to the late Mr. H. Rouse, dips 1 in 4 easterly, until it reaches a vertical depth of 110 feet, where a steep fault or break, having a westerly dip, was encountered. In this break a formation was found, and was followed down under the reef to a depth of 28 feet, where the work was abandoned. This is shown in Fig. 2.

FIG. 2.



SECTION ACROSS THE HIGHLAND MARY REEF.

Showing a formation on the face of the hard granite bar.

3. Mr. Rouse also stated that there is no defined break in the No. 1 P.C. Underlie, but a formation exists without a reef, and at the bottom the hanging wall turned steeply over.

4. A vertical reef is supposed to exist about 300 feet in front (*i.e.*, to the east of the outcrop) of the main line of reef, and it has been suggested that this vertical reef is on a line of fault, corresponding with the break shown in Fig. 2.

5. In the Highland Mary No. 1 Block Shaft (*i.e.*, No. 1 and 2 United Blocks) a reef is said to exist at a depth of 300 feet from the surface, but the prospects at the time of sinking were not satisfactory, and a reef previously passed through at 180 feet was opened up. From this top reef two crushings were taken, yielding respectively 36 dwt. and 33 dwt. of gold to the ton.

6. The Glengarry Reef, so Mr. S. Murdock states, has *never* been lost, but has split up into numerous leaders, which he anticipates will come together lower down.

The returns of gold given further on are from all the mines along the Highland Mary Line, and one prominent feature that may be pointed out in connection with these yields is that the whole of the gold which has an aggregate value of £241,167 has been obtained close to the surface, and within a little less than half a mile along its course.

REEFS ADJACENT TO BENNION'S MINE.

Sovereign and Post Hole Reef.—The principal workings on this reef are those in the shaft known as "Sandy Brown's Sovereign and Post Hole Subsidy Shaft," which has been sunk to a depth of 366 feet. The reefs are not well defined, are said to merge into one another, and are considered portions of the main Iguana Reef.

In the above-mentioned shaft a reef was found at about ninety feet from the surface, and below this a series of small leaders occur in a dark, fine-grained hornblende granite, locally termed "diorite." The reef at ninety feet was worked in a level driven northerly for sixteen feet, but was cut off by a nearly vertical fault, and has not since been found.

In Sircom Street the Sovereign Reef is supposed to overlie the Post Hole Reef, but from the information supplied by the miners who were working in the reefs here some years ago, it would appear that the Post Hole Reef is only an upper portion of the Sovereign Reef, faulted on a slide which dips in a direction the reverse to the dip of the reef, and having a section somewhat like that shown diagrammatically in Fig. 3.

The positions of the reefs are shown on Plate 6, and the returns showing the yields of gold from the stone crushed are given on page 15.

Just-in-Time Reef.—This reef seems at one time to have been a portion of the Sovereign Reef, although now the distance between the

two is considerable. In Sircom Street, and also at the junction of this and Brown Street, masses of quartz have been found, not connected in any way with a reef, but indicative of the disturbance of the rocks in the vicinity. The country here may have been disturbed before the reefs came into existence, but it is very probable that movements to form fissures and infiltration of quartz into the fissures to form reefs were going on simultaneously.

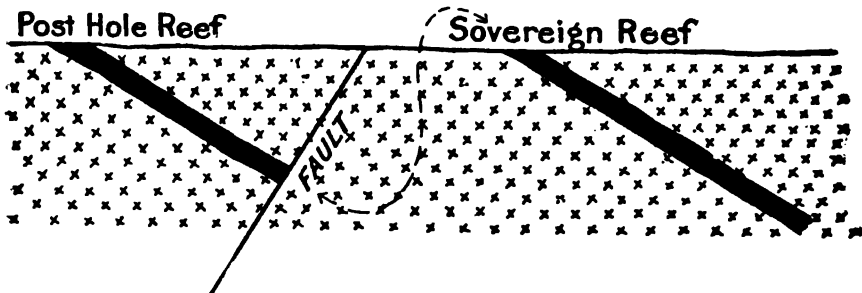
Apparently a large shear-plane, having a dip to the south, has cut off the upper portion of the Sovereign (Iguana) Reef, and that a movement took place to fault this upper portion down the dip of the shear-plane, and to form what is now known as the Post Hole Reef.

Subsequently the moved portion of the Sovereign Reef—i.e., the Post Hole—has been broken by a vertical joint at right angles with the shear-plane, and a second movement, to the west of this vertical joint-plane, has shifted the reef, and the country with it, further to the south, leaving the Post Hole portion of the reef in the position which the first movement placed it. If these conditions be true, the Just-in-Time Reef would be the Sovereign Reef at its second movement, and, consequently, this line of reef would be of limited extent along its eastern trend, and would also pinch out or fault against the shear-plane when worked to the dip. Should such a movement dislocate any of the reefs in this neighbourhood, it would be necessary to rise up on the fault towards the surface to find their continuation, provided, of course, they have not been already exposed on the surface in this direction.

The workings of this reef have not been examined, but it is understood that they are not very extensive, neither were the returns very satisfactory when the mine was last worked.

The position of the Just-in-Time Reef is shown on Plate 6, and the tabulated returns of the stone crushed are given on page 15.

FIG 3



DIAGRAMMATIC SECTION ACROSS THE POST HOLE AND SOVEREIGN REEFS.

Showing the probable faulting of the Post Hole Reef from the top of the Sovereign Reef.

The *Sir Walter Reef* appears to be an eastern extension of the Just-in-Time Reef, from which it has been separated by a complexity of movements. The apparent fault on the vertical joint-plane in Sircom Street has caused a disturbance in the eastern continuation of the Just-in-Time, and the fault in Aldridge Street seems to have further added to the confusion.

Close to the hard granite bar, the Sir Walter is divided into two parallel reefs. The upper reef trends west-south-west, but turns sharply to the north-west at its south-easterly end, to trend parallel with the Sovereign, the other end of the reef coming up against the hard granite bar almost at right angles, and then turning around to join a leader lying parallel with the head.

Near the granite bar the lower reef is only separated from the upper one by a few inches, but as it trends to the south-west this distance increases until, where the top reef trends to the north-west, it continues on in the direction of the Just-in-Time.

The south-eastern face of the hard granite bar, at the north-eastern extremity of the Sir Walter Reef, has a dip to the south-west, and, as shown on the plan, comes in contact with the reef much further west where the workings have revealed it in the deeper levels. This is due to the reef dipping north-west, and the face of the bar dipping south-west.

The rocks about the reef are granites, more or less decomposed, but always containing graphite, which on the Croydon field is ever considered a gold indicator. The surface features of the Sir Walter Reef are shown on Plate 6, and in greater detail on Plate 7, its position with regard to the hard granite bar being shown on Plate 9.

The returns of gold from the workings on this reef are given further on.

The Lady Mary Reef.—The position and features of this reef are shown on Plate 6, and in greater detail on Plate 7. It has been worked extensively along the surface, and has proved very richly gold-bearing. The reef is well defined near the junction of Brown and McArthur Streets, its most south-easterly extremity, and has a distinct westerly dip, but changes rapidly a little further north-west to a basin-shaped deposit.

There is a large dyke mass close to the reef in McArthur Street (*see* Plate 7), which may have had some bearing on its irregular structure, and on its disappearance along a fault plane in the ground west of the outcrop. The reef rises to the surface further north, and on Block LXXIII., north of Brown Street, it became exposed as a horizontal sheet of quartz, all of which was found to be gold-bearing.

The belt of hard granite with which the Sir Walter Reef came in contact has disturbed the Lady Mary Reef, and there is a possibility that on the north-eastern side of this hard belt the Lady Mary would

make again, and be found as a continuation of the small reef now being worked in Bennion's Mine, although a greater probability exists that it is another reef altogether.

The returns from the Lady Mary Reef are attached.

BENNION'S MINE AND REEF.

Operations started on this reef by a series of 23 bores being sunk in the north-eastern corner of Block LXVI. A well in the vicinity revealed a soft formation of graphitic granite about thirty feet from the surface, and the bores were put down to strike this formation at a greater depth. The bore records show, however, that the sinking was not deep enough, except in the last bore, to meet the formation, the obstacles in the way of deep sinking being the granite boulders occurring just below the surface.

The position in the well in which the formation occurs at a depth of thirty feet is represented in the section on Plate 9, the position of a similar formation met with in Bennion's shaft at eighty feet being also shown.

The outcrop of the hard belt of granite previously referred to is situated to the west of the mine, but there is evidence of another belt of granite occurring to the east of Bennion's Shaft, the Sir Walter and Lady Mary Reefs being to the west of the former bar, Bennion's workings lying between the two. (See Plates 7 and 9.) The soft formation found in Bennion's Well and Shaft lies between the two belts or bars of hard granite; whilst to the west of the first, or main bar, there is also a soft, decomposed graphitic granite, the country in which the Sir Walter and Lady Mary Reefs occur.

There is some probability of the two belts of soft granite once being continuous, but they are now broken, and have been faulted by a movement on the west side of the main bar, the fault being about parallel with the general strike of the Sovereign and Lady Mary Reefs. This fault seems to have thrown down the country on the west side of the bar, bringing the soft graphitic granite containing the Sir Walter and Lady Mary Reefs against the hard granite. The section on Plate 9 illustrates this view of the subject, but to establish it as a fact more evidence is required concerning the thickness of the soft granitic belt at Bennion's Mine, in comparison with the soft granite in the vicinity of the Sir Walter and adjacent reefs, and also some evidence showing the character of the rocks to the north-east about the Black Snake Reef, whether the hanging-wall country of the latter corresponds to the country to the east of the bar and whether the footwall country correspond to the country on the west of the bar. If these could be correlated, it would rather show that the faulted portion of the Lady Mary-Sovereign-Iguana Reef is the Black Snake line of Reef.

It has been previously stated that the Just-in-Time and Sir Walter Reefs are probably separate portions of the same reef, and that the Sovereign and Post Hole Reefs are related to the Just-in-Time. The

Sovereign in making a bend in its course (as shown on Plates 6 and 7) and connecting with the Lady Mary, probably crosses the line of the Sir Walter, and so produces some confusion in this locality. Bennion's Reef, when discovered on the eastern side of this belt, was at first thought to be a continuation of the Just-in-Time and Sir Walter Reefs, but subsequent investigations showed it to have the same course as the Lady Mary, and to have some resemblance to this reef in other respects.

The workings at Bennion's Mine consist of two shafts, a well, a level, and two crosscuts. No. 1 shaft has been sunk vertically to a depth of 194 feet, meeting the formation similar to that found in the well at 80 feet from the surface, and a reef at 155 feet. The underlie from this shaft was put down at 155 feet on the reef, which proved to be poor, about eight inches in thickness, and having an inclination of 1 in 3 to the south-east.

A level driven to the north-west exposed the reef for a distance of about thirty feet. A large formation accompanies the reef, but the reef itself contains two or three inches of payable gold-bearing stone.

Another level was driven from the shaft in a south-easterly direction, and, following the trend of the reef, was continued to the south-west, but no great variation in the size of the reef was observed, although the stone averaged in places between seven and eight ounces of gold to the ton. The level for the last eight feet was driven in footwall granite country, because the reef became very small, and because the appearance of the formation met with in driving was considered a favourable indication of the presence of a larger reef in the vicinity. A reef was not found, however, and a crosscut was then driven to connect the level with the No. 2 Shaft, some small, nearly vertical, quartz leaders being met with in the crosscut when making the connection.

No. 2 Shaft is situated about 150 feet in a southerly direction from No. 1 Shaft. No indication of a reef was found in sinking, and at 145 feet the work was discontinued, but later on the shaft was sunk to 160 feet, and a short crosscut at this depth, driven to the south-west in a large formation, met a reef eight inches thick. This is considered by some to be the same reef as that found in No. 1 Shaft, but as that (No. 1) reef becomes smaller in size as it trends to the south-east, probably it dies out altogether. On the other hand, the reef found in No. 2 Shaft, which cannot be connected with the first one on account of the failure to find it in the level and the long crosscut, is probably another reef altogether, which would most likely become smaller as it trends to the north-west, and larger as it trends in the opposite direction.

It is rather premature to make any observations on the behaviour of the reefs on this side of the main granite bar, but if the above conditions prevail, then we may expect the reefs to pinch out, or enlarge, within short distances, and that where one pinches out another is making in either the footwall or hanging-wall country.

The plan of these workings are shown on Plate 8, the general position of the reef with respect to other reefs in the vicinity being shown on Plate 7.

It is proposed to further sink No. 2 Shaft, and subsequently to continue the work of development in the direction of the Lady Mary Reef, or rather where this reef would be found, if it exists, on the eastern side of the hard granite belt. The results of this development it will be impossible to forecast, but the remarkable yields of gold from this neighbourhood certainly warrant something being done to ascertain if the rich Lady Mary Reef continues over the bar into the deep ground. Should rich reefs be discovered, no doubt the whole of the mines along this wonderful line of reef—from Iguana Hill to the Highland Mary—will again be taken up as leases, and worked vigorously by mining companies.

THE GOVERNMENT BORE ON THE IGUANA REEF.

This bore was the fourth sunk by the Government to test the reefs in deep ground, and is located 1,300 feet from the outcrop of the Iguana Reef, the position being shown on Plate 6. Boring operations began on the 21st November, 1891, and were discontinued on the 18th December, 1893, the total depth bored being 532 feet. The object of boring was to meet the Iguana Reef, or the Chance Reef, which junctions with the Iguana; but the work proved a failure, as neither reef was found. The inclusion here of the record of the bore is desirable, in view of the contemplated development at Bennion's reef, on which it will probably have some bearing.

NO 4 BORE (ELLIOT'S).

	Surface.
Red gravel conglomerate	13'6
Red conglomerate with hard granite boulders	19'6
Hard grey granite, more or less jointy	26'0
Very hard grey granite*	57'6
Extremely hard grey granite	110'6
Hard grey granite, very jointy†	242'1
Yellowish and grey granite with quartz veins‡	275'9
Grey granite	288'9
Extremely hard grey granite	309'3
Yellowish-grey granite formation, with 9 inches quartz vein|| ... ..	405'0
Red granite	415'6
Extremely hard grey granite	443'9
Hard grey granite, very jointy	496'3
Extremely hard grey granite	504'3 to
Boring discontinued at	532'0

* "Total cost of boring to this depth was about £2 15s. per foot."

† "Cost of boring between 102 and 264 feet was £2 11s. 7d. per foot."

‡ "At a depth of 257 feet 10 inches, the extremely hard grey granite in which the drill has been boring almost from the surface was passed through, meeting with a very different kind of granite."

|| "At 405 feet the extremely hard granite gave place to a yellow granite formation with numerous small quartz veins or leaders, which continued to 412 feet 4 inches, when 3-inch vein of white quartz was pierced, dipping at an angle of 30 degrees from the horizontal, and passing into a yellow granite formation with quartz veins. Quartz tested, and found it to contain a large amount of iron pyrites, but without a trace of gold."

BATTERY RETURNS.

FROM MINES ON THE HIGHLAND MARY LINE OF REEF, AND THOSE
NEAR BENNION'S REEF, AT CROYDON.

(From the Commencement of the Field up to the end of the Year 1905.)

Details of Battery Returns.

Year.	Name of Mine.	Stone Crushed.	Yield.	Average Value per oz. (approx- imate).	Total Value (approx- imate).
		Tons cwt.	Oz. dwt. gr.		
SOVEREIGN AND POST HOLE REEFS.					
1887	Sovereign P.C.	58 0	214 17 0		
"	" No. 1	74 0	675 0 0		
"	Post Hole	84 10	783 16 0		
1888	Sovereign No. 1 East	26 0	9 0 0		
1891	" United	5 2	7 12 0		
"	Sovereign and Post Hole Ext'd.	9 0	15 13 0		
"	" " " " " "	5 0	3 18 0		
"	Post Hole	12 0	6 0 0		
1892	Sovereign and Post Hole Ext'd.	138 0	195 18 0		
"	Post Hole	4 10	3 1 0		
1893	Sovereign and Post Hole Ext'd.	259 0	223 9 0		
1894	" " " " " "	120 0	163 19 0		
1897	Sovereign and Post Hole ...	10 0	8 7 0		
1898	" " " " " "	5 0	4 4 0		
1899	" " " " " "	5 0	7 15 0		
"	Post Hole	54 0	51 6 0		
	Total	869 2	2,373 15 0	£2/9/-	£5,816-
SIR WALTER REEF.					
1887	Sir Walter P.C.	100 0	673 5 0		
1888	" " " " " "	80 0	477 0 0		
1889	" " " " " "	74 10	279 0 0		
1890	" " " " " "	641 0	1,761 6 0		
1891	" Tribute	20 0	23 13 0		
"	" and Lady Mary	91 14	294 7 0		
"	" and Lady Mary	20 0	21 17 0		
1892	" P.C.	45 5	41 2 12		
1893	" " " " " "	108 14	144 8 0		
1894	" " " " " "	92 10	91 18 0		
1895	" " " " " "	72 5	67 0 0		
1896	" " " " " "	51 0	59 11 0		
1897	" " " " " "	12 0	5 3 0		
"	" 1 South	10 0	15 0 0		
1898	" " " " " "	13 15	25 4 0		
1900	" " " " " "	7 0	11 0 0		
1901	" (surface)	6 0	10 18 0		
1902	" " " " " "	10 10	15 10 0		
	Total	1,454 3	4,017 2 12	£2/12/6	£10,545-
JUST-IN-TIME REEF.					
1887	Just-in-time P.C.	104 0	225 0 0		
"	" 1 East	68 0	112 14 0		
"	" 2 East	100 0	100 0 0		
"	" 1 West	62 0	61 17 0		
1888	" " " " " "	4 5	3 10 10		
1889	" P.C.	65 0	70 0 0		
"	" 2 East	31 17	31 0 0		
1890	" " " " " "	36 0	42 4 0		
1891	" " " " " "	2 10	14 10 0		
"	" P.C.	22 10	23 7 0		
1892	" " " " " "	26 14	19 15 0		
1893	" " " " " "	3 0	1 10 0		
1898	" " " " " "	15 10	23 6 12		
1899	" " " " " "	110 5	167 6 18		
1903	" Tribute	193 0	119 5 0		
	Total	844 11	1,015 5 16	£2/16/6	£2,868-

BATTERY RETURNS—*continued.*

Year.	Name of Mine.	Stone Crushed.	Yield.	Average Value per oz. (approximate).	Total Value (approximate).
		Tons cwt.	Oz. dwt. gr.		
LADY MARY REEF.					
1887	Lady Mary P.C. ...	243 0	1,359 1 0		
"	" No. 1 ...	201 0	1,180 0 0		
"	" No. 1 North ...	96 0	400 18 0		
"	" No. 1 South ...	25 0	27 19 0		
1888	" P.C. ...	560 10	1,925 14 0		
"	" No. 1 ...	184 0	343 0 0		
1889	" P.C. ...	965 0	1,954 8 0		
"	" No. 1 North ...	51 0	101 0 0		
"	" No. 1 South ...	51 18	67 17 0		
1890	" P.C. ...	957 0	1,558 19 0		
"	" No. 1 North ...	65 0	82 7 0		
1891	" P.C. ...	1,112 10	1,371 2 0		
1892	" " ...	1,619 0	2,924 7 0		
1893	" " ...	757 2	1,195 11 6		
"	" No. 1 North ...	12 2	7 17 0		
1894	" P.C. ...	329 0	504 12 6		
1895	" " ...	251 13	206 13 6		
1896	" " ...	88 15	305 10 0		
"	" (surface) ...	10 0	2 16 8		
1897	" P.C. ...	67 5	114 14 0		
"	" No. 2 ...	9 0	20 0 0		
"	" (surface) ...	95 0	45 16 0		
1898	Lady Mary P.C. ...	342 10	222 9 18		
1899	" " ...	12 0	12 4 0		
"	" (surface) ...	3 0	1 12 0		
1900	" " ...	8 0	8 13 0		
1901	" " ...	7 10	5 15 0		
"	" (surface) ...	23 0	28 0 0		
1902	" " ...	59 0	95 15 0		
1903	" " ...	107 10	197 15 0		
1904	" " ...	20 0	23 19 0		
1905	" " ...	11 10	18 14 0		
	Total ...	8,344 15	16,313 18 20	£2/11/-	£41,600
BRADLAUGH MINE.					
1888	Bradlaugh P.U. ...	49 15	84 16 0		
1889	" " ...	19 0	12 17 0		
1890	" " ...	95 0	85 15 6		
1891	" " ...	14 0	24 1 12		
1892	" " ...	...	...
to	" " ...	...	...
1905	" " ...	...	...
	Total ...	177 15	207 9 18	£2/16/6	£586
CALEDONIA MINES.					
1886	Caledonia No. 1 East ...	136 0	630 9 12		
1887	" P.C. ...	154 0	1,073 0 0		
"	" No. 1 East ...	136 0	630 0 0		
1888	" P.C. ...	562 10	2,926 0 0		
"	" No. 1 East ...	340 0	1,571 0 0		
1889	" P.C. ...	576 0	832 0 0		
"	" No. 1 East ...	238 10	694 10 0		
"	" Nos. 1 and 2 East ...	312 0	992 10 0		
1890	" P.C. ...	190 0	335 4 6		
"	" Nos. 1 and 2 East ...	463 0	1,055 2 0		
1891	" " ...	158 0	547 17 0		
"	" P.C. " ...	7 0	17 5 0		
1892	" " ...	261 0	333 5 0		
1893	" " ...	674 0	378 1 0		
1894	" " ...	335 5	506 16 18		
1895	" " ...	462 10	728 13 12		
1896	" " ...	178 0	181 8 8		
"	" (surface) ...	40 10	45 16 4		
"	" East ...	12 0	6 15 0		

BATTERY RETURNS—*continued.*

Year.	Name of Mine.	Stone Crushed.	Yield.	Average Value per oz. (approximate).	Total Value (approximate).
		Tons cwt.	Oz. dwt. gr.		
CALEDONIA MINES—continued.					
1897	Caledonia P.C.	5 10	13 0 0		
"	" (surface)	34 0	11 7 0		
1898	"	177 0	120 10 0		
1899	"	454 0	734 18 0		
1900	"	40 0	33 10 0		
"	" P.C.	90 0	48 10 12		
1901	"	338 0	264 10 0		
		T. O. G.			
1902	"	16 6 2	15 15 0		
1903	"	161 10 0	138 12 0		
1904	"	19 0 0	18 0 0		
1905	"	9 0 0	10 10 0		
	Total ...	6,520 11 2	14,894 15 18	£2/16/6	\$42,078

HIGHLAND MARY MINES.

1887	Highland Mary P.C. ...	483 0	728 0 0		
"	" No. 1 North ...	69 0	105 10 0		
"	" No. 1 South ...	153 0	328 0 0		
"	" No. 2 South ...	211 0	831 5 0		
"	" No. 3 South ...	94 0	98 17 0		
1888	" P.C. ...	1,043 0	2,010 6 0		
"	" No. 1 North ...	70 0	127 1 0		
"	" No. 1 South ...	343 0	760 17 12		
"	" No. 2 South ...	417 0	1,442 6 10		
"	" No. 3s South ...	50 0	67 18 0		
1889	" P.C. ...	1,808 10	4,482 0 0		
"	" No. 1 North ...	81 0	26 2 0		
"	" No. 1 South ...	1,118 0	3,074 14 0		
"	" No. 2 South ...	1,499 0	3,068 14 0		
"	" No. 3s South ...	225 0	420 4 0		
1890	" P.C. ...	1,007 0	1,889 1 0		
"	" No. 1 South ...	1,891 10	3,829 17 0		
"	" No. 2 South ...	2,057 5	2,063 7 6		
"	" No. 3s South ...	413 10	732 5 0		
"	" No. 2 South ...	51 0	57 0 0		
"	" No. 3 West ...	34 0	27 2 0		
1891	" No. 2 South ...	235 10	296 6 0		
"	" No. 3s South ...	441 0	956 4 12		
"	" No. 1 South ...	473 0	817 1 0		
"	" No. 1 North ...	427 0	547 18 0		
"	" P.C. ...	1,470 5	2,686 1 18		
"	" No. 3 Block ...	385 0	1,074 9 0		
1892	" P.C. ...	2,031 0	5,054 18 8		
"	" No. 3s South ...	712 0	1,875 8 6		
"	" No. 1 South ...	295 0	483 0 0		
"	" No. 2 South ...	626 0	981 6 6		
"	" No. 1 North ...	241 19	178 8 0		
1893	" P.C. ...	2,027 13	3,196 6 18		
"	" No. 1 South ...	126 0	151 1 0		
"	" No. 2 South ...	225 0	245 12 0		
"	" No. 3s South ...	623 10	1,453 5 0		
"	" No. 1 ...	15 0	22 10 0		
"	" No. 1 North ...	17 0	15 0 0		
1894	" P.C. ...	682 10	914 18 12		
"	" No. 2 South ...	27 0	16 12 0		
"	" No. 3s South ...	386 0	645 0 21		
1895	" P.C. ...	417 10	340 2 20		
"	" No. 1 South ...	10 0	17 10 0		
"	" No. 2 South ...	54 0	66 7 0		
"	" No. 3s South ...	151 0	168 0 12		
1896	" United ...	432 0	861 8 0		

BATTERY RETURNS—*continued.*

Year.	Name of Mine.	Stone Crushed.	Yield.	Average Value per oz. (approximate).	Total Value (approximate).
		Tons cwt.	Oz. dwt. gr.		
HIGHLAND MARY MINES—continued.					
1886	Highland Mary P.C.*	22 0	14 17 15		
"	" No. 1 South	33 0	6 4 12		
"	" No. 1 North	21 0	10 8 0		
"	" No. 3s South	104 0	100 8 12		
"	" (surface)	257 10	232 3 4		
1897	United†	1,088 0	2,458 10 0		
"	" No. 2 South	34 0	22 10 0		
"	" No. 3s South	600 0	640 7 12		
"	" (surface)	1,531 15	247 4 0		
1898	"	234 0	207 1 0		
"	" United†	256 0	263 16 0		
"	" No. 3s South	247 10	223 18 12		
1899	United†	153 10	44 16 12		
"	" (surface)	206 10	109 15 18		
"	" No. 3s South	88 0	91 7 0		
1900	" (general)	44 0	74 6 0		
"	" (surface)	36 10	48 13 0		
1901	" (surface)	6 0	9 0 0		
"	" No. 3s	72 0	36 4 0		
1902	" (general)	25 0	21 16 0		
"	" No. 3s	43 0	47 0 0		
1903	" (general)	71 10	67 7 0		
1904	"	77 0	65 0 0		
1905	"	48 10	44 8 0		
Total ...		30,950 17	54,325 4 18	£2/8/-	£130,380

GLENGARRY MINE.

1887	Glengarry P.C. ...	156 0	490 0 0		
1888	" ...	397 0	934 12 0		
1889	" ...	875 0	2,044 0 0		
1890	" ...	1,000 0	3,152 16 12		
1891	" ...	2,921 10	11,010 12 17		
1892	" ...	655 10	1,737 16 15		
1893	" ...	401 5	526 11 12		
1894	" ...	130 10	124 3 20		
1895	" ...	59 0	73 14 0		
1896	" (surface) ...	27 0	21 3 0		
1897	" (surface) ...	38 0	25 5 0		
"	" ...	68 0	31 16 0		
1898	" ...	28 10	14 0 0		
1899	" ...	44 0	16 19 0		
1900	" ...	27 0	20 0 0		
1903	" ...	18 0	15 0 0		
1904	" ...	7 0	7 0 0		
1905	" ...	6 0	7 8 0		
Total ...		6,859 5	20,242 18 4	£2	£40,496

SIR GARNET MINES.

1887	Sir Garnet P.C. ...	410 0	1,192 18 0		
1888	" ...	150 0	628 13 0		
"	" 3 and 4 United ...	376 0	592 8 22		
1889	" P.C. ...	721 0	1,848 2 0		
"	" Nos. 1 and 2 ...	28 0	36 17 0		
"	" Nos. 3 and 4 ...	68 0	199 11 0		
"	" Nos. 3 and 4 South ...	42 0	44 18 0		
"	" No. 1 West ...	22 10	19 10 0		
"	" United ...	10 0	4 0 0		

* Worked as the United after this date. † See also Highland Mary P.C. returns prior to this date.

BATTERY RETURNS—*continued.*

Year.	Name of Mine.	Stone Crushed.	Yield.	Average Value per oz. (approximate).	Total Value (approximate).
		Tons cwt.	Oz. dwt. gr.		

SIR GARNET MINES—*continued.*

1890	Sir Garnet P.C. ...	499 0	1,972 3 6		
"	" 1 and 2 United ...	43 10	54 7 3		
"	" 3 and 4 United ...	72 0	220 17 18		
"	" West ...	14 0	10 0 0		
1891	" P.C. ...	196 4	673 9 0		
"	" 1 and 2 United ...	182 0	202 12 0		
"	" United ...	110 0	264 13 0		
"	" Consolidated ...	160 0	105 3 0		
1892	" P.C. ...	181 0	345 16 0		
"	" United ...	47 0	164 6 8		
1893	" P.C. ...	61 0	83 13 22		
"	" United ...	20 0	15 12 0		
"	" Nos. 3 and 4 ...	17 6	10 5 0		
1894	" P.C. ...	53 10	74 11 6		
"	" Limited ...	10 10	9 1 0		
1895	" P.C. ...	6 0	12 5 0		
"	" United ...	26 6	30 6 12		
1896	" ...	32 0	15 7 0		
1897	" ...	97 0	35 0 0		
"	" (surface) ...	35 0	20 0 0		
1898	" Extended ...	43 0	26 15 0		
1899	" P.C. ...	10 0	9 3 0		
"	" (surface) ...	78 0	13 19 0		
	Total ...	3,821 16	8,936 4 1	£2/12/-	£23,234

ARCHER MINES.

1887	Archer P.C. ...	18 0	39 5 0		
1888	" ...	259 15	398 8 12		
"	" United ...	21 0	104 1 7		
"	" No. 2 West ...	26 0	13 7 12		
1889	" Syndicate United ...	194 0	635 1 0		
"	" Block ...	23 0	18 18 0		
"	" No. 1 ...	25 0	21 0 0		
"	" No. 1 West ...	17 0	45 2 0		
"	" No. 1 West Block ...	62 10	47 5 0		
"	" Limited ...	61 17	66 11 0		
1890	" Syndicate ...	148 0	191 12 12		
"	" P.C. ...	228 0	625 16 8		
"	" No. 1 ...	68 0	67 19 0		
"	" Block ...	20 0	51 0 0		
1891	" P.C. ...	322 10	463 9 2		
"	" No. 1 East ...	23 0	15 0 0		
"	" Nos. 1 and 2 ...	25 0	10 15 0		
1892	" P.C. ...	125 8	195 3 0		
"	" No. 1 ...	15 0	18 17 0		
1893	" P.C. ...	69 12	47 1 0		
"	" No. 1 ...	7 10	5 15 12		
1894	" P.C. ...	32 1	22 1 0		
"	" (Loya) ...	15 0	10 16 8		
"	" (McLean) ...	27 0	9 7 12		
1895	" P.C. ...	38 10	84 17 0		
"	" (Gay and party) ...	25 0	21 4 0		
1896	" ...	148 0	185 1 0		
"	" No. 1 ...	25 0	15 10 0		
1897	" ...	24 10	10 7 0		
1898	" ...	17 0	14 15 18		
1899	" (surface) ...	4 0	2 1 14		
	Total ...	2,121 3	3,457 8 21	£2/12/-	£23,969

Summary of Battery Returns.

Name of Mine.	Stone Crushed.	Yield.	Average Value per oz. (approximate).	Total Value (approximate).
MINES NEAR BENNISON'S REEF.	Tons cwt. qr.	Os. dwt. gr.	£ s. d.	£ s. d.
Sovereign and Post Hole Reef	869 2 0	2,373 15 0	2 9 0	5,816 0 0
Sir Walter Reef	1,454 3 0	4,017 2 12	2 12 6	10,545 0 0
Just-in-Time Reef	844 11 0	1,015 5 16	2 16 6	2,868 0 0
Lady Mary Reef	8,344 15 0	16,313 18 20	2 11 0	41,600 0 0
Bradlaugh P.C. ...	177 15 0	207 9 18	2 16 6	586 0 0
MINES ON THE HIGHLAND MARY REEF.				
Caledonia Mines—				
Caledonia P.C. ...	3,435 15 0	7,373 4 2	2 16 6	20,829 0 0
" East, No. 1 East, and No. 2 East	1,795 10 0	6,128 3 12	2 16 6	17,312 0 0
" (surface) ...	74 10 0	57 3 4	2 16 6	162 0 0
" (locality not stated)	1,214 16 2	1,335 5 0	2 16 6	3,775 0 0
Highland Mary Mines—				
Highland Mary P.C.*	10,992 8 0	21,316 12 19	2 8 0	51,159 17 0
" No. 1 North	926 19 0	1,010 7 0	2 8 0	2,424 16 0
" No. 1 South	4,442 10 0	9,468 5 0	2 8 0	22,723 15 0
" No. 2 South	5,436 15 0	9,094 5 22	2 8 0	21,826 4 0
" No. 3a South†	4,250 10 0	7,556 8 15	2 8 0	18,135 7 0
" United‡	1,929 10 0	3,628 10 12	2 8 0	8,708 8 0
" (surface) ...	2,038 5 0	646 15 22	2 8 0	1,552 4 0
" No. 3 West	34 0 0	27 2 0	2 8 0	65 0 0
" No. 3 Block	385 0 0	1,074 9 0	2 8 0	2,578 14 0
" No. 1	15 0 0	22 10 0	2 8 0	54 0 0
" (locality not given)	500 0 0	479 18 0	2 8 0	1,151 15 0
Glangarry P.C. ...	6,859 5 0	20,242 18 4	2 0 0	40,486 0 0
Sir Garnet Mines—				
Sir Garnet P.C. ...	2,287 14 0	6,840 14 10	2 12 0	17,785 16 0
" (other than the P.C.)	1,534 2 0	2,095 9 15	2 12 0	5,448 4 0
Archer Mines—				
Archer P.C. ...	1,093 16 0	1,876 0 22	2 12 0	4,877 10 0
" (other than the P.C.)	1,027 7 0	1,581 7 23	2 12 0	4,111 10 0
Totals ...	61,963 18 2	125,784 3 8	2 8 9	306,582 0 0

* Worked as the United after 1895—see Annual Report, Department of Mines, 1896.

† Includes No. 3 South returns for 1887, and No. 3a returns for 1901 and 1902.

‡ See also Highland Mary P.C. Returns.

PLATE 1.

GENERAL PLAN OF THE HIGHLAND MARY AND OTHER REEFS AT CROYDON.

The position of the Highland Mary, Caledonia, Lady Mary, Sovereign, Sir Walter, Just-in-Time, Post Hole, Iguana, Bennion's, and other reefs are indicated on the map; also the portion of the long line of reef parallel with the Iguana-Highland Mary line, and known by the names Waratah, Black Snake, The Queen, &c.

an of the Highland Mary er Reefs at Croydon

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Dunstan Acting Govt Geologist
1907

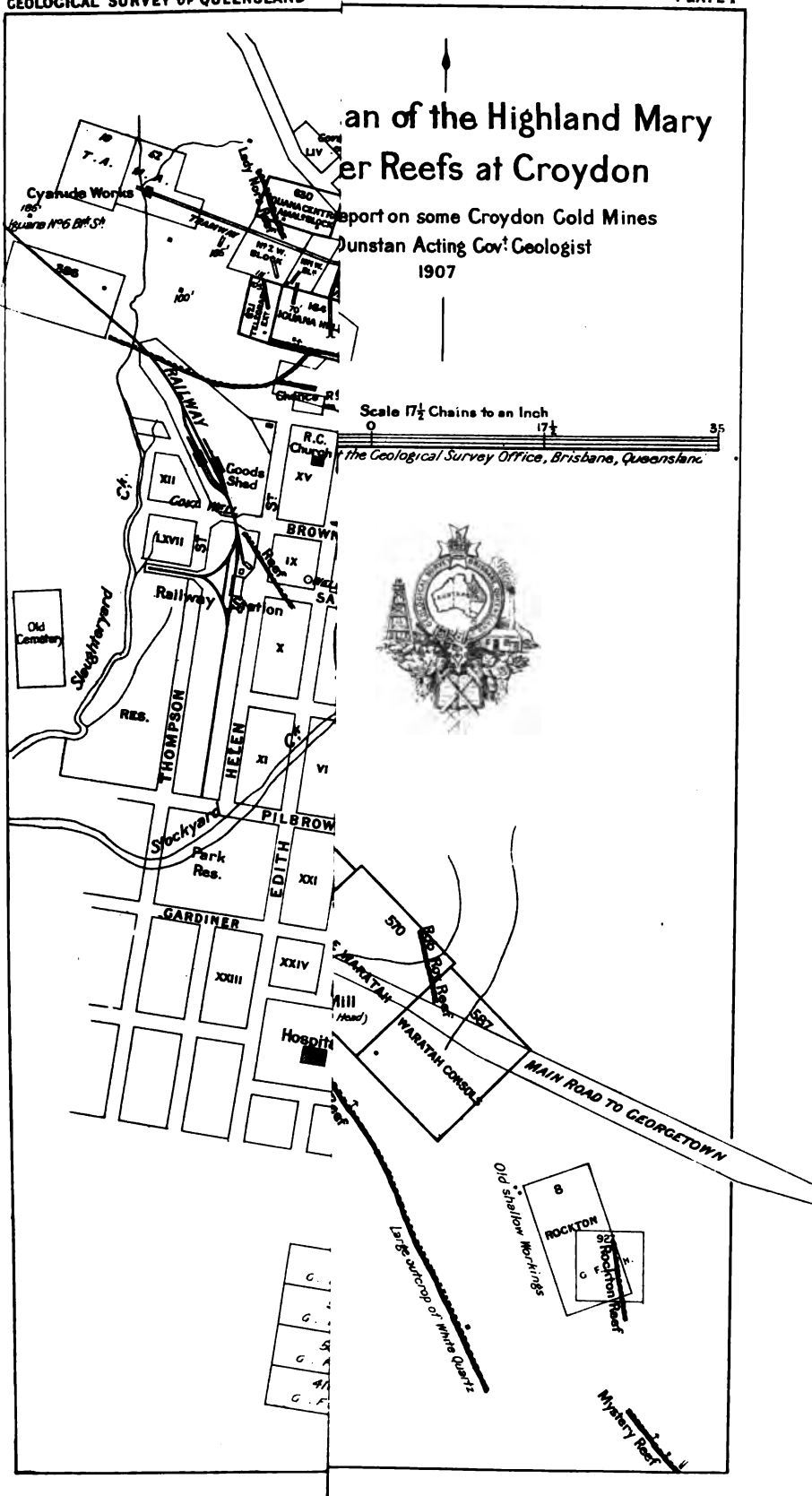


PLATE 2.

PLAN OF THE HIGHLAND MARY LINE OF REEF.

Showing old and new leases, bores, and existing and proposed shafts.

REFERENCE.

- A. Position of proposed shaft, 1,800 feet from the outcrop of the reef.
 - B. The No. 1 South Block Shaft which it was proposed to work.
 - C. Borehole No. 1. *See* Plate 4 for record.
 - D. Borehole No. 2. *See* Plate 3 for record.
 - E. Borehole No. 3. *See* Plate 5 for record.
 - F. The Highland Mary Extended Block Shaft where work is now in progress.
- For section on line A-B, *see* Plate 3.
For section on line C-D, *see* Plate 4.
For section on line E-F, *see* Plate 5.

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PLATE 3.

**SECTION ACROSS THE HIGHLAND MARY REEF, ALONG LINE A-B (SHOWN
ON PLATE 2).**

This is a section across the Caledonia P.C. workings, showing the position in the underlie where the reef was cut off against a granite head or bar, and also the place where it was found when the underlie was continued through this bar, and where it was again lost further down the workings in the granite.

The record of No. 2 bore-hole is shown on the plate, and indicates the kind of rock which the Caledonia P.C. Underlie would probably have met with if further continued into the deep ground.

1. Introduction

2. Methodology

3. Results and Discussion

4. Conclusion

5. References

6. Appendix

7.

8. Acknowledgements

9. Author Biographies

Section across the Highland Mary Reef along Line A-B on Plate 2

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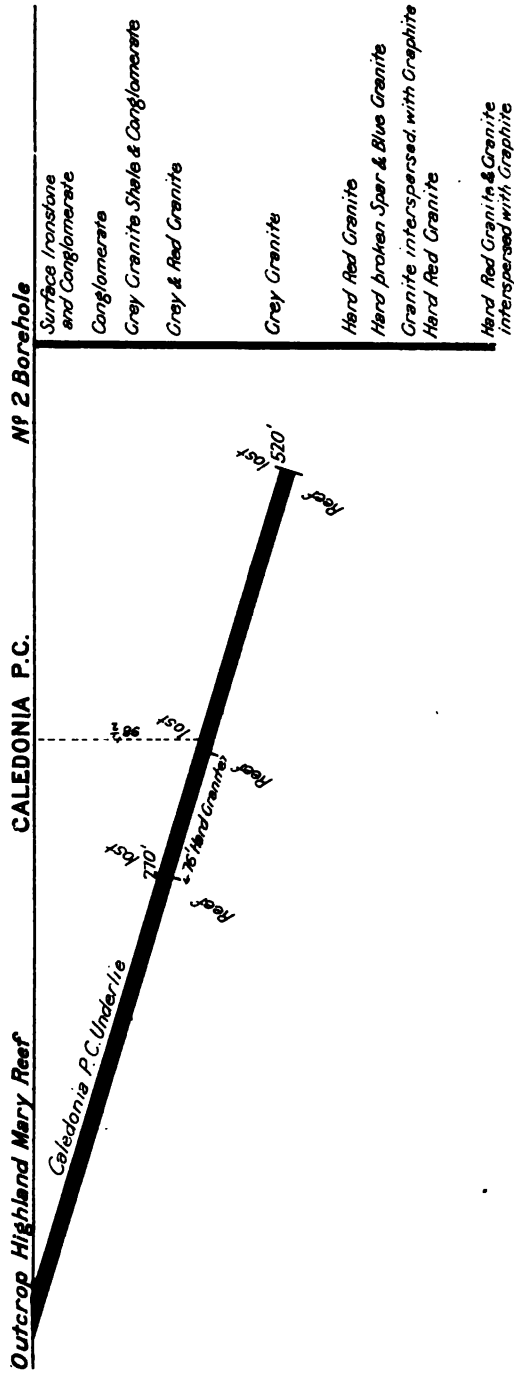
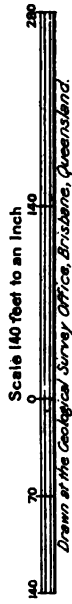


PLATE 4.**SECTION ACROSS THE HIGHLAND MARY REEF, ALONG THE LINE C-D ON
PLATE 2.**

The section shows the outcrop of the Highland Mary Reef at the back (west) of the No. 1 South Underlie Shaft, and at the back of the No. 2 South Underlie Shaft. It also shows the position of No. 1 bore-hole, and the record of the rocks passed through, together with the position of the Highland Mary Extended Block Shaft, where operations have started with the object of finding the lost reef. When the shaft has been repaired and cleaned out, the course of action will then depend on the information obtained from an examination of the underground workings.

Section across the Highland Mary Reef along line C-D on Plate 2

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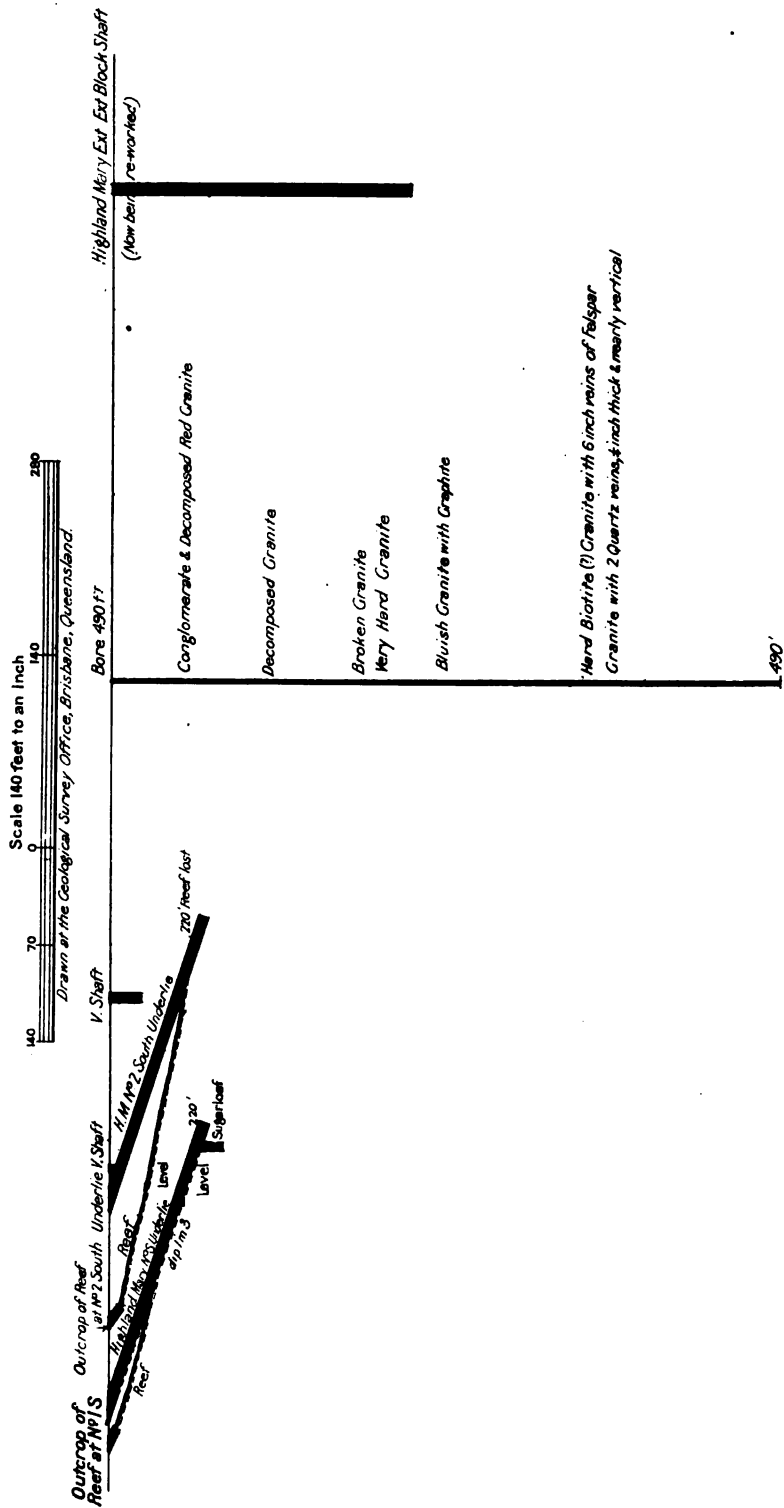


PLATE 5.**SECTION ACROSS THE HIGHLAND MARY REEF, ALONG THE LINE E-F
ON PLATE 2.**

The section is in a line with No. 3 bore-hole, and is taken across the workings of the Glengarry Mine and the Highland Mary No. 3A and B South Underlie Shafts. There is not much difference to be observed in making a comparison of the records of the three bores, and if the information is reliable it would seem, in view of the uniformity of the bar or break on the west side of the line of bores, that nothing is to be gained in prospecting on that side, and that operations should be confined to the east of the line of bores.

1. The first part of the paper is devoted to the study of the asymptotic behavior of the solutions of the system of equations (1) as $\epsilon \rightarrow 0$. It is shown that the solutions of the system (1) converge to the solutions of the system of equations (2) as $\epsilon \rightarrow 0$. The convergence is uniform on compact subsets of the domain Ω .

2. In the second part of the paper, the asymptotic expansion of the solutions of the system (1) is constructed. It is shown that the asymptotic expansion of the solutions of the system (1) has the form

$$u = u_0 + \epsilon u_1 + \epsilon^2 u_2 + \dots$$

where u_0, u_1, u_2, \dots are functions defined on the domain Ω . The functions u_0, u_1, u_2, \dots are determined by the system of equations (2) and the boundary conditions (3).

3. In the third part of the paper, the asymptotic expansion of the solutions of the system (1) is used to study the asymptotic behavior of the solutions of the system (1) as $\epsilon \rightarrow 0$. It is shown that the solutions of the system (1) converge to the solutions of the system of equations (2) as $\epsilon \rightarrow 0$. The convergence is uniform on compact subsets of the domain Ω .

Section across the Highland Mary Reef along the Line E-F on Plate 2

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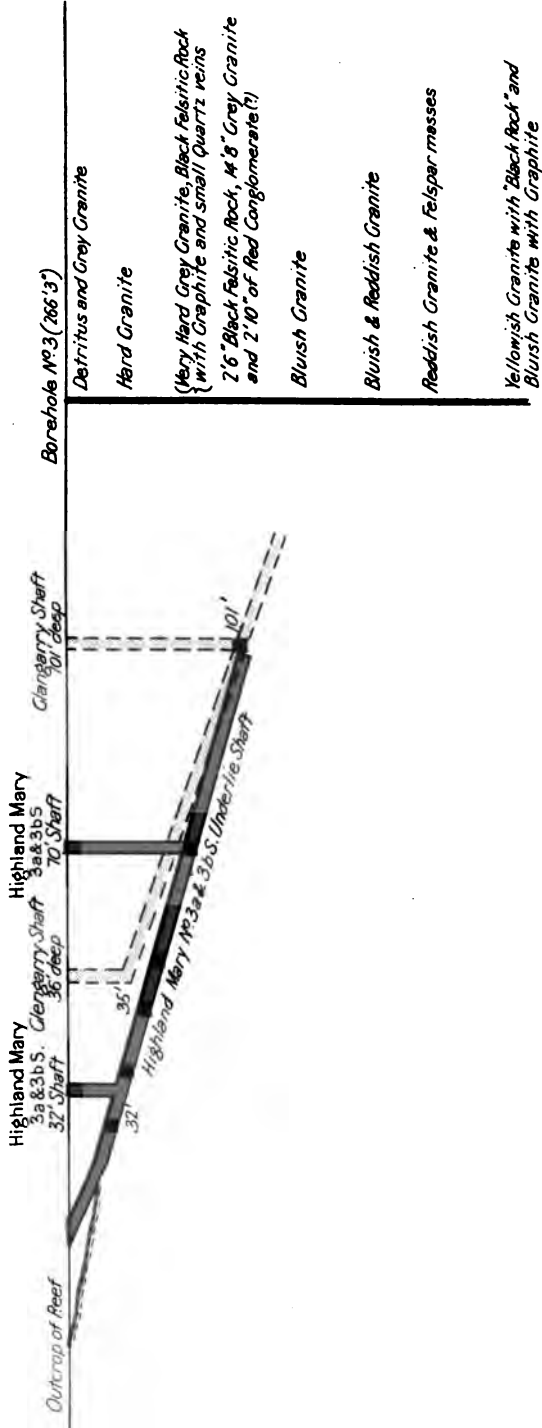
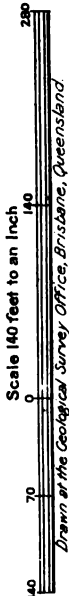


PLATE 6.

PLAN OF THE REEFS IN THE TOWN OF CROYDON.

On the plan the general features of the reefs in the vicinity of Bennion's Mine and towards Iguana Hill are shown, and also the trend and position of the Iguana, Chance, Golden Butterfly, Sovereign, Post Hole, Just-in-Time, Sir Walter, and Lady Mary Reefs.

Many of the leases are abandoned, but the names are retained for purposes of identification.

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PLATE 7.**DETAIL PLAN OF REEFS IN THE VICINITY OF BENNION'S MINE.**

This plan shows the position of Bennion's Reef, the adjoining reefs, and the old workings in the vicinity. The geological features indicate that considerable faulting in the granite has taken place, and that while some reefs, as the result, have been disturbed, there is a great probability of other reefs having come into existence after the disturbance took place. The confusion resulting from the disturbance causes some trouble in following the behaviour of the reefs, and also a difficulty in understanding the results of observations made by individual miners.

The details of this plan are referred to in several portions of the text.

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PLATE 8.**PLAN OF THE WORKINGS ON BENNION'S REEF.**

The dotted line along the level represents the trend or strike of the (No. 1) reef, the dip being a general eastern one at an angle of about 1 in 3 from the horizontal. The south-eastern extension probably will be found to the north-east of No. 2 Shaft—if the reef does not pinch out.

The reef (No. 2) found in the short crosscut to the south-west of No. 2 Shaft will probably trend in a direction parallel with No. 1 Reef, and some possibility exists of it making larger as it is followed to the south-east.

Plan of Workings on Bennion's Reef

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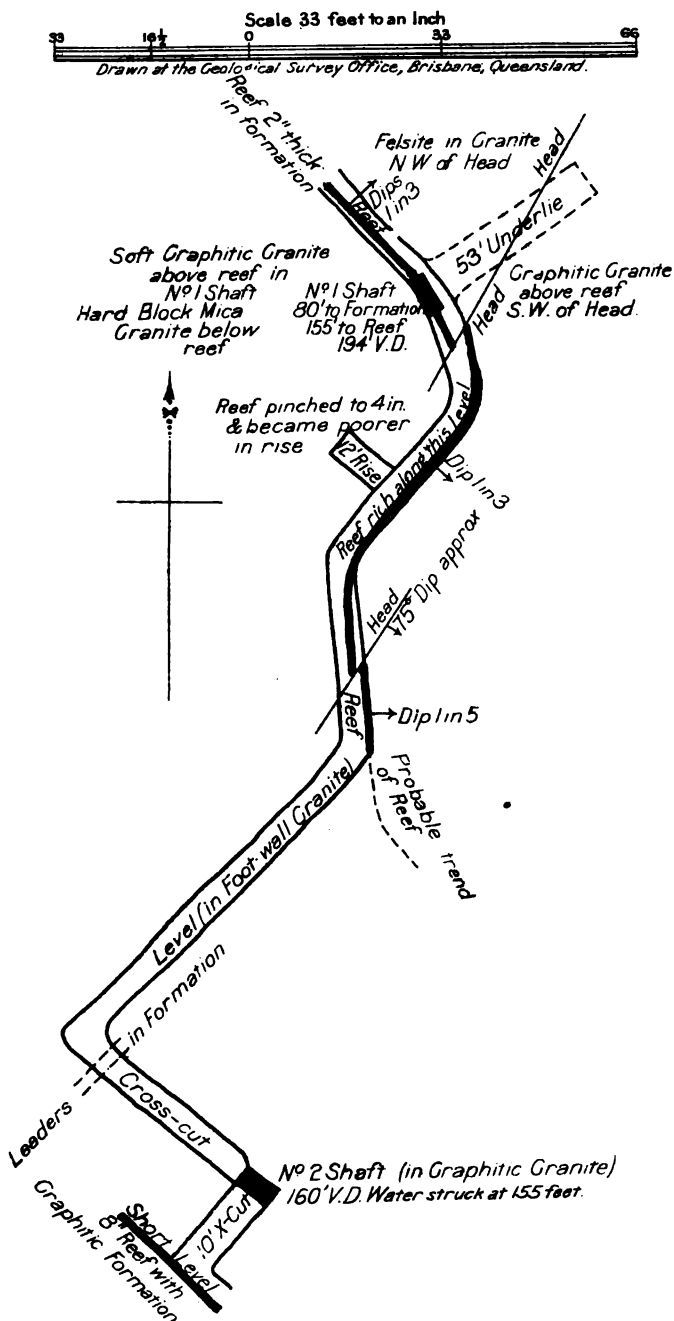


PLATE 9.

DIAGRAMMATIC SECTION AT BENNION'S MINE.

Showing the position of the Sir Walter and Sovereign workings, the break and leader which the Sir Walter Reef met with, and the graphitic formation passed through in both Bennion's Well and No. 1 Shaft.

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Section A-B Plate 7 being a Diagrammatic Section between the Sovereign Reef & Bennion's Reef. Length of Section 1000 feet

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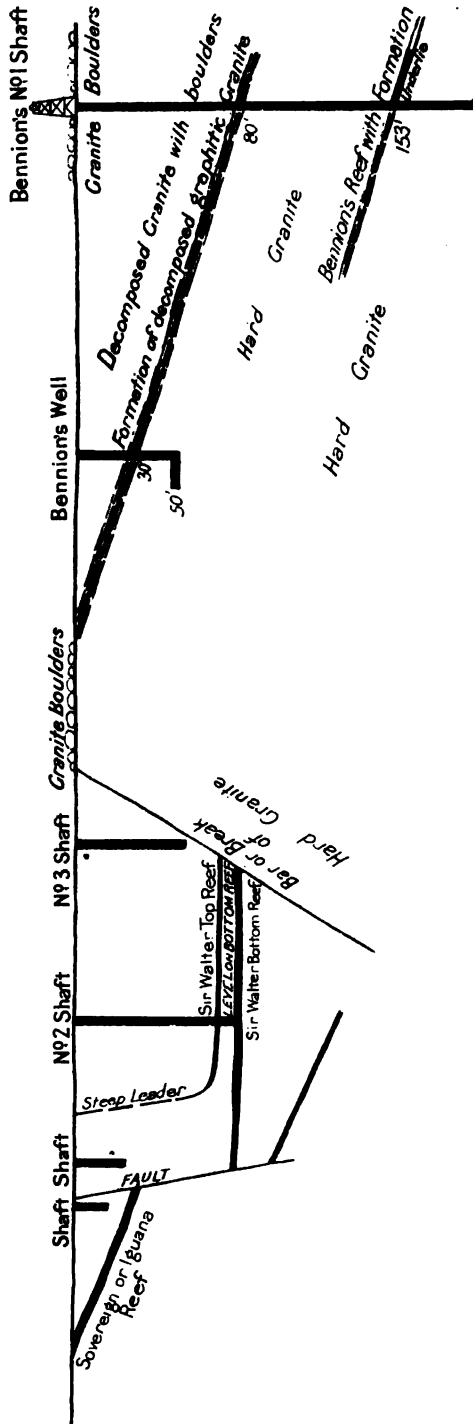


PLATE 10.

BENNION'S MINE, CROYDON.

The photo. is taken from a position north-west of the main (No. 1) shaft. The underlie is dipping towards the front of the picture, the level making an irregular course to the No. 2 shaft in the distance.

Plate 18.



BENNION'S MINE, CROYDON.



Basalt, Diorite &c.



Date Due